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An Asterisk (*) denotes an illustrated article

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[OFFICIAL NOTICE.]

Seventeenth Annual Meeting, Western Gas Association.

SECRETARY'S OFFICE, WESTERN GAS ASSOCIATION,
QUINCY, ILLS., April 24, 1894.

The seventeenth annual meeting of the Western Gas Association will be held at Cleveland, O., on the 16th, 17th and 18th of May.

The Hollenden, strictly first class in all its appointments, will be the Association's headquarters, and its business sessions will also be conducted therein. The rates at the Hollenden will be as follows: On the American plan, $3, $3.50, $4 and $5 per day. On the European plan, $1, $1.50, $2, $3 and $3.50 per day.

It is intended that an exhibit of gas appliances shall form one of the prominent features of the Cleveland meeting, and to this end a commodious storeroom, directly across the street from the Hollenden, has been engaged. Manufacturers and dealers in stoves, ranges, burners, lamps, engines and all forms and types of apparatus or machinery by which the manifold uses of gas can be exhibited, are respectfully invited to display their wares; and they can feel assured that, on this occasion, the same will be critically inspected by large and appreciative audiences. Communications on the subject can be addressed to Mr. M. S. Greenough, General Manager of the Cleveland Gas Light and Coke Company, who will take pleasure in furnishing to exhibitors all requisite information in the matter.

The following papers will be presented for the consideration of the members of the Western Gas Association on the occasion of its seventeenth annual meeting:

"Street Main Pressure," by Irvin Butterworth, Columbus, O.

"Some of the Advantages of Oil Gas Works for Small Towns," by J. W. Stratton, Valparaiso, Ind.

"The Best Method of Introducing Gas Stoves," by H. Wilkiemeyer, Evansville, Ind.

"Three Years in a Country Gas Works," by S. M. Highlands, Clinton, Ia.

"History of the Gas Meter," by Wm. McDonald, Albany, N. Y.

"How to Make Small Electric Light Plants Pay," by I. C. Copley, Aurora, Ills.

"Influence of Temperature on Purification," by Jas. Ferrier, Columbus, Ga.

"Report of the Committee on Electrolysis," by Geo. T. Thompson, Jas. Somerville and Alten S. Miller.

Paper by Chas. H. Evans, Chicago, Ills., title not yet received.

Geo. T. Thompson, of the Laclede Gas Light Company, St. Louis, Mo., has been appointed Superintendent of the Wrinkle Department for the coming meeting, and to him should be addressed all contributions to or communications bearing on subjects connected with said department, while all matter for the Question Box should be mailed to the Secretary.

The Committee of Arrangements—Messrs. M. S. Greenough (Chairman), D. R. Warmington, C. M. Higgins, Chas. R. Faben, Jr., Irvin Butterworth and Joseph Light—announce that a complimentary dinner will be tendered to the members of the Association, by the Gas Companies of Cleveland and some of the manufacturers of the same city, at the Hollenden, at 8 o'clock, P.M., Thursday, May 17th.

A meeting of the Board of Directors of the Association will be held at the Hollenden, at 10 o'clock, A.M., Tuesday, May 15th, and it is earnestly hoped that every member of the Board will find it convenient to be present.

A hearty invitation is hereby extended to the members of kindred Associations to be present at the meeting and to participate in its proceedings; and this invitation is further extended to the fraternity generally.

Rates of one and one-third fares for the round trip will be made, by the various Passenger Associations, to our members and their friends. This reduction is based on the certificate plan, as in former years.

The undersigned will be pleased to reply to all communications requesting detailed information concerning the meeting, not covered by this announcement and the notices which are to follow.

A. W. LITTLETON, Secretary.

BRIEFLY TOLD.

ALMOST READY FOR THE CLEVELAND CONVENTION.—Secretary Littleton's current official notice regarding the coming convention of the Western Association at Cleveland shows that little remains uncompleted in respect of arranging the preliminaries. Like the methodical man that he is, the Secretary puts forth in sensible terms just what may be looked forward to, and his programme certainly confirms the intimations hitherto made in the JOURNAL that the Cleveland convention would be most enjoyable in all respects. The paper list promises nine separate numbers—for we presume the report of the committee on electrolysis can fairly be regarded a paper—and President Jenkins' address assures the members of ten contributions that are certain to lead to profitable discussion. The titles of the papers, too, confirm the belief that diversity in gas technology is not at an end, for of the eight that are promised and named, seven can certainly be said to be on subjects

that are distinctive; and it is also fair to assume that the contribution by Mr. Evans will not trench on the ground taken by the others. One may further note from the list that several of the authors have yet to make their appearance as formal contributors to the proceedings of any of our Associations, although they have all been well schooled, either as listeners to or participants in many interesting debates. We think we are safe in saying that Messrs. Highlands, McDonald, Copley, Ferrier, and, possibly, Mr. Stratton, are to present initial essays, and, judging from the success these gentlemen have gained in their respective fields, what they will have to say will come sealed with the stamp of experience. The most encouraging sign, however, in the appearance of so many new names is the fact that it indicates, not only the growth and strength of the Western Association, but also shows the vitality of the gas business. When gas men are at so little stress to find matters of such wide range for presentation to their fellows, who may gainsay the activity of their art? It goes without repeating that the Secretary's hearty invitation on behalf of the Association to gas men in general to attend the meeting is just what it purports to be—a positive hope they will come in numbers to share the Association's hospitality.

OBITUARY, MR. HENRY FREDERICK ALLEN.—Our last issue contained a brief announcement of the death of Mr. H. F. Allen, whose demise occurred at his home in this city on the afternoon of April 16th, and it is mainly through the courtesy of Mr. Walter A. Allen (Superintendent of the Municipal Gas Company, of Albany, N. Y., a brother of deceased) that we are enabled to place before our readers the following account of his life: Henry Frederick Allen was born in New York City, August 14th, 1844, and having received a good round of training in the public school of his district, entered the services of the Ericsson Machine Works, the shops of which were located in Jersey City, serving a thorough apprenticeship in its machine shops and draughting room. Deceased showed great aptitude for draughting, and assisted in preparing the plans for the first seven monitors of the nine famous war vessels of that type, which were sent out by the famous Ericsson and his aides. He next accepted a post in the United States Navy as assistant engineer, and served with distinction in that branch of the service until the close of the war. Re-entering civil life, he was employed by the Newark (N. J.) Gas Company, but remained there only a short time because of his acceptance of an offer from the New Britain (Conn.) Bank Lock Company, the proprietors of which had conceived the idea of placing on the market the celebrated time locks. Deceased was one of the designers of the first locks of this description that met with approval. In 1878 he was appointed Superintendent of the New York Mutual Gas Light Company, succeeding the late Mr. Parham, a position in which he made a most brilliant success, for to-day the Company stands second to none in the country. He was a devoted member of the Society of Gas Lighting, gave loyal support to the American Society of Mechanics and Tradesmen, and to the Loyal Legion. Mr. Allen was prominent in local yachting circles, respecting which diversion he was almost an enthusiast, having acted for many years as Commodore of the Hudson River Yacht Club. In 1874 he was united in marriage to Miss Jennie Porter, of Newport, N. Y., who survives, as does a daughter. Deceased was a lovable man, whose genial nature and cheery ways were always tempered by respect for himself and by regard for his associates.

NOTES.—The proprietors of the Hamilton (Ont.) Gas Light Company have met with much success in their efforts to popularize the use of gas for cooking. At least so we gather from the inspection of a very well put together and cleverly illustrated circular which they are now distributing in their city, and which details the advantages of gaseous fuel, for the names of 252 householders who use gas for purposes other than lighting are given in its pages.——The Erie (Pa.) Gas Company, having determined to remodel and enlarge its manufacturing plant, has awarded to Mr. Fred. Bredel, of Milwaukee and New York, contracts for the entire work, which include the following: A new building, 190 feet by 32 feet, will contain boiler and engine rooms, condensing and purifying house, meter and office rooms. The engine and condenser room will have 1 Wilbraham exhauster, now in use in the present plant and in good order, 1 Roots exhauster, 2 air condensers, 2 tar and carbonic acid extractors, 1 seven-foot compensator, and 1 ammonia extractor—the last six named apparatus to be of Bredel's patented construction. The purifiers, two in number, are each 22 feet by 28 feet, with bucket elevators and hoisting machinery for the covers. The benchwork consists in re setting five benches of 6's with outside generator. The new 9 foot 6-inch meter will be erected in a room sufficiently large to serve for office purposes.

Memorial Action Taken by the Society of Gas Lighting Respecting Mr. F. A. Sabbaton and Mr. H. F. Allen.

The following is a report of the proceedings of a special meeting of the Society of Gas Lighting, called for the purpose of passing appropriate minutes to the memory of Mr. F. A. Sabbaton and of Mr. H. F. Allen:

FREDERICK A. SABBATON.

At a special meeting of the Society of Gas Lighting, held in the city of New York, Wednesday, April 18, the following minute was unanimously adopted:

The members have heard with deep regret of the decease of our friend, Frederick A. Sabbaton, of Troy, N. Y., who, since the year 1876, has been connected with the Society as a non resident member.

He came of a family whose name is most honorably and pre eminently connected with the gas industry of the country, and was distinguished as a most capable and successful engineer and manager of gas undertakings, and for his integrity.

His intercourse with the members of the Society was most pleasant, and was characterized by unfailing courtesy and geniality of manners, and his presence will be sadly missed, not only on account of his being a most agreable associate and companion, but also because of his learning and large experience in all things pertaining to the manufacture and distribution of gas, and the interest he took in the welfare of the Society, and because of his contributions to its papers.

Resolved, That this minute be entered upon the records of the Society and be printed in the AMERICAN GAS LIGHT JOURNAL, and that a copy be sent to the family of Mr. Sabbaton.

EUGENE VANDERPOOL,
WILLIAM H. BRADLEY,
A. M. SMITH,
} Committee.

HENRY F. ALLEN.

At a special meeting of the Society of Gas Lighting, held in the city of New York, Wednesday, April 18, the following minute was unanimously adopted:

The members of the Society have been much shocked and pained at the sudden and unexpected death of our member, Henry F. Allen, Engineer and Superintendent of the New York Mutual Gas Light Company.

Mr. Allen was constant in his attendance at the meetings, and added much to their interest by the presentation of papers, by taking an active part in the discussions, and by the introduction of new or interesting subjects for investigation connected with the manufacture or chemistry of gas lighting, particularly when meetings were held at the works of the New York Mutual Gas Light Company.

He had been for many years connected with the management of his Company, and had their entire confidence, not only on account of his competency as Engineer and Superintendent of the works, but also on account of his energy, diligence and strict integrity.

Mr. Allen had served his country during the troubled times of the war, in the engineering department of the navy, and with high distinction.

His death comes as a great loss to the members, on account of his unremitting attendance at the meetings, his generous and manly impulses, his thoughtfulness and kindness to all, his genial spirits and flow of wit, and because he had the best interests of the Society deeply at heart.

Resolved, That this minute be entered upon the records of the Society and be printed in the AMERICAN GAS LIGHT JOURNAL, and that a copy be sent to the family of Mr. Allen.

EUGENE VANDERPOOL,
WILLIAM H. BRADLEY,
A. M. SMITH,
} Committee.

The Science and Progress of Gas Combustion.

[Abstract of a paper read by Mr. C. R. Bellamy, Supt. of the Gas Department of the Liverpool Corporation, at a meeting of the Liverpool Engineering Society.]

In his opening remarks, the author stated that if he had written his paper before fixing the title, the latter would have read: "The Progress of the Science of Gas Combustion," as it was obviously of more interest to the engineer, in a pape of this character, to deal with the march of practical results than with the causes which led up to them. The strictly scientific considerations had therefore been omitted, and the paper would partake more particularly of the character of a *resume* of the work ac-

complished in the direction of improved methods of gas combustion, having for their object the attainment of a higher lighting duty from coal gas. He then went on to say that the consideration of such a subject would not appear as one of much int rest to the casual observer; but, taking into consideration the magnitude of the gas industry in this country—which, though having a history of barely a century, involved an annual coal consumption of 11 million tons, and the production of 111,000 million cubic feet of gas, realizing, with residual products, upwards of 18½ million pounds sterling—and, when it was known that one burner might develop ten times as much light as another with the same consumption of gas, it would be seen that the matter was of sufficient importance to warrant investigation.

Mr. Bellamy next quoted the report presented to the Board of Trade by the Gas Referees in 1871, to show that, as the result of testing a large number of gas burners removed from various public buildings and places of business, the greater portion of them were found to give out only one half, and some not more than one fourth, of the light which might have been developed from the gas. If this rate of waste were applied to the gas rental of the country, the enormous loss to the community, due to ignorance of the simple laws governing gas combustion, would, he said, be apparent. Since the date of that report, great progress had been made in the manufacture of gas burners and in perfecting the details of gas combustion. But there had not been that general recognition by the public that should have followed; and it was safe to assert that from 20 to 25 per cent. of the gas used for lighting purposes to-day was wasted—occasioning not only a monetary loss, but also interfering with health and comfort. He thought that one of the principal causes of this state of things was that gas authorities had chiefly applied their energies in the direction of improving the quality and lowering the price of their commodity, thus allowing the fitting of houses with gas appliances to get into the hands of a class of men who were chiefly interested in selling the cheapest and most inferior article at an enormous profit, regardless of its suitability or economic principles. This type of person was known as a gasfitter, unless he styled himself a gas engineer; but in either case it would be well to bear in mind that, with rare exceptions, he was densely ignorant of the technology of his calling, and could not therefore be regarded as a source of reliable information. It was the hope of the author that his paper might supply some reliable data upon the subject of gas lighting which would be of service to the members of the Society, when, in the course of their multifarious duties, they had to deal with the problems of gas lighting.

Before dealing with the various forms of burners and the improvements effected therein, Mr. Bellamy defined some of the terms he would have to employ. Taking illuminating power first, he said he thought the standard candle was very unreliable and unscientific and was only used when statutory or official obligations required it, as the precautions and calculations necessary to correct its vagaries were great, and only partially successful, so that its use was dispensed with wherever permissible. The standard of light more commonly used was the Methven screen. Having described this instrument, he then proceeded to point out that the mere expression "candle power of coal gas" is not very instructive, unless the burner by which it is measured is referred to. There were, he said, several standard burners in use in this country, which gave very divergent results. He showed four which had come under his immediate notice—viz. (1) the 15-hole Argand, (2) the Silber Argand, (3) the London Argand, and (4) Sugg's No. 7 steatite batswing. The two last named were, he explained, those adopted by the Gas Referees—the "London" Argand for testing gases varying between 14 and 18 candle power, and the batswing for those of higher illuminating value. The unit efficiency of these four burners with Liverpool gas was: (1) 3.24 candles, (2) 4.19 candles, (3) 3.8 candles, and (4) 4 candles. The importance of describing the form of burner used, when referring to the candle power of gas, would be apparent. The author thought it was distinctly unfortunate, for comparative purposes, that there was not one standard of illuminating value for coal gas applicable to the whole country, and one standard burner prescribed for its measurement; and he said it would no doubt cheapen gas considerably if the illuminating standard were fixed at a point which would enable the gas to be produced from ordinary coal. A great advantage of such an arrangement would be that one form of burner would be usable throughout the country; whereas, under the present condition of things, such a burner as the batswing had to be made to three or four different gauges to suit gases varying between 14 and 20 candle power, if the best results were to be obtained. This refinement of burner manufacture, although very important, was rarely carried out in detail; and therefore thousands of burners, made in different parts of the country for gas of low illuminating power, were used locally, to the great detriment of the gas.

Having explained the terms "duty," as applied to a burner, and "pressure," as regards the supply of gas thereto, Mr. Bellamy proceeded to describe, from "Accum," the earliest form of burner—the "cockspur." Contrasting this with a single jet burner of modern type, he showed that the gas, when lighted, ascends in a stream—rising until it comes into contact with sufficient oxygen to complete its combustion. To prevent the flame becoming unduly long, it was, he said, necessary to restrict the orifice; and the gas, issuing at considerable pressure, tended to draw in the air and mix with it in its course. This resulted in a considerable loss of illuminating power, evidence of which was afforded by the well known Bunsen burner. He then made some brief general remarks upon the chemical and physical properties of a gas flame, with the view of illustrating the bad effect of excessive pressure; and he showed that any system which has a tendency to keep the temperature of the flame high, with a low velocity of the issuing stream of gas, must be a beneficial one. All improvements in the methods of gas combustion had been in this direction. The main defect in the old "cockspur" burners was that the flame obtained with them was very unstable—being affected by the most trivial atmospheric movement. This led to the introduction, about 1816, of the "batswing," and about 1822 of the "fishtail" burner; the latter being the product of the united labors of Mr. J. B. Neilson and Mr. J. Milne—the first named gentleman being at that time Manager of the Glasgow gas works, and Mr. Milne being the founder of the well known engineering firm of Messrs. J. Milne & Sons, of that city. The utility of both of these burners had been further enhanced by forming them wholly or in part of non conducting material, such as adamas, enamel, or steatite. The author exhibited two burners of each of the new types, and showed that the unit efficiency of the fishtail had increased from 1.66 to 3.09 candles, and that of the batswing from 3.01 to 4 candles. He stated that the increased efficiency of the new over the old type amounted to 47 per cent. in the case of the former, and to 25 per cent. in that of the latter burner. These results were obtained by adjusting the pressure to the requirements of the burner. This was a most important matter. There was for every form of burner one pressure at which it would yield its most economic results; and various efforts had been made to maintain it. Gas was forced through the mains at a much higher pressure than it was desirable to have at the burner. This could not be avoided, owing to the variation of level in the districts supplied, the distance to which it had to be sent, and other causes. The extreme variation in Liverpool was between 1 and 2.8 inches, which was very moderate, owing to the efficient system of mains in use. In many towns, however, the range of pressure was between 0.5 and 4 inches.

The author then went on to say that the effect of variations in pressure on the consumption and illuminating power of gas had been so disastrous that governors for automatically adjusting the flow of gas to any desired pressure, had been introduced. These instruments had passed through many changes, but they might be regarded as having now reached the maximum of efficiency. A governor of the best type would maintain the pressure absolutely at any desired point through all the ranges of pressure referred to. There were two principal forms—viz., main governors for controlling a number of lights, and the single form for governing the burner to which it was attached. The latter combination was by far the most efficient, and undoubtedly constituted the most important improvement effected in connection with the combustion of gas. The following table—giving the results of consuming gas by means of governed and ungoverned burners—demonstrates the extent of this this improvement:

Description of Burner.	Pressure. Inches.	Consumption. Cubic Feet.	Unit Efficiency. Candles.
Governor burner, rated at 5 cubic feet per hour	0.5	5.00	4.20
	1.0	5.00	4.20
	1.5	5.00	4.20
	2.0	5.00	4.20
	2.5	5.00	4.20
	3.0	5.00	4.20
Ordinary ungoverned burner No. 4	0.5	3.90	3.00
	1.0	5.60	2.40
	1.5	7.00	1.90
	2.0	8.45	1.50
	2.5	9.60	1.35
	3.0	10.50	1.11

Referring to these figures, the author explained that the ungoverned burner was one of the ordinary type of brass-cased fishtails, which constitute between 80 and 90 per cent. of the total number of burners at present in use; and he remarked that, though useful by comparison with its progenitors, it must eventually be superseded by the batswing in combination with the governor or other improved form.

Before leaving the subject of flat flame burners, Mr. Bellamy made

reference to the use of globes. He said these had been very much improved during the last few years, both in form and suitability of the material employed. The old type, with a restricted opening at the bottom, caused the air to rush in with considerable violence, resulting in great unsteadiness of the flame, and an actual diminution of the yield of light. The new form—known as the "comet" or "moon"—was of real assistance to the flame when placed in its right position relatively to the burner, which is when the bottom of the globe and the top of the burner are in the same horizontal plane. In this position, the globe exerts a steadying influence on the flame, and assists in maintaining a higher temperature about it. The absorptive power of the commoner type of globe is very great, varying between 25 and 40 per cent.; but with the better form, manufactured of a description of glass known as "albatrine," the absorption, when measured on the horizontal line, does not exceed 18 per cent. In explanation of this apparently low result, the author pointed out that, in the use of such a globe, while there is necessarily absorption on one side, there is considerable reflection at the back of the flame from the other. Thus, if an "albatrine" or opal globe were split in half vertically, and the front half removed, it would be seen at once that the back half acts as a very powerful reflector. It is really doubtful, he thought, in point of general illuminating effect, whether there is any loss of light by the use of a properly constructed globe, as there is considerable reflection upwards and downwards to compensate for the deficiency on or near the horizontal line. He showed photometrical results obtained from a flat flame burner, measured at angles of 10° from the vertical above to the vertical below, obtained by Mr. Dibdin with his radial photometer. They indicated, at a glance, that there is very little, if any, loss of light by the use of a suitable globe, while the general advantages consequent upon its use are obvious.

Passing next to the subject of the Argand burner, the author remarked that this had a higher efficiency than those of the flat flame type, but this superiority had not been sufficient to counteract the disadvantages attendant upon the use of the glass chimney, and therefore it had not come into very g neral favor. Some improvements had, however, been made in it, the aggregate effect of which was increased efficiency. There had been a variety of modifications and improvements in the "London" Argand, the details of which he had not time to give.

The other burners noticed by Mr. Bellamy were those of the regenerative and incandescent types. He stated that the principal feature of the former class was the conveyance of air for supporting combustion through chambers heated by the gas flame, resulting in an increased temperature of the flame itself, and an additional lighting efficiency of about 25 per cent. over that of the best form of flat flame governor burners. They had not been adopted in the general manner first expected, owing largely to the amount of attention they required; but for combining ventilation with lighting, where the diffusion of the products of combustion was objectionable, they were invaluable. He showed a sample of one of the smallest of its type. It was rated at 3.9 cubic feet per hour; and it yielded a light equal to 26.99 candles—showing a unit efficiency of 6.92 candles. This was the most generally useful burner of its class.

With regard to the incandescent burner, Mr. Bellamy made the following remarks, and with these his paper closed: This is a form in which the "Bunsen" burner with a non-luminous flame is used, light being obtained by enveloping the flame in a garment of some refractory material capable of being raised to a useful state of incandescence. The earliest examples were those of Clamond and Lewis; the former employing a mantle of magnesia spun into threads, the latter a cage of platinum wire. Both required an artificial blast of air, and therefore could not be placed on the list of appliances applicable to ordinary conditions. They were, however, the forerunners of the form of burner which, in my opinion, is destined to entirely revolutionize both gas lighting and gas manufacture. Sir John Conroy stated before the Royal Society in 1891, as the result of elaborate experiments, that the total radiation from the Argand gas burner was composed of 1.75 per cent. of luminous, and 98.25 per cent. of non-luminous rays. It has always been regarded as a reproach to mechanical engineering that the best steam plant only gives a useful duty of about 10 per cent. of the theoretical capabilities of the fuel burnt in a boiler furnace. This, however, appears a favorable result in contrast with the gas burner, which wastes 98.25 per cent. of the gas it consumes, so far as lighting effect goes. The gas cannot be burnt without heat; but it would appear that a system which ignores the light-rays of 1.75 per cent., and utilizes the heat-rays of 98.25 per cent., is likely to secure the most economic result. This system is practically embodied in the incandescent burner before you, which is a modification of the Welsbach burner introduced in 1886. Mr. Bellamy, having briefly described the burner, proceeded: As the result of numerous tests the author is enabled to state that this burner has a unit efficiency of 19 candles; and when this is compared with the 4 candles of the best type of flat flame burner, the enormous advance in light production will be apparent. An appliance which suggests the possibility of a reduction in the gas bill of 75 per cent. inspires respect; and with care, allowing for new mantles, a light could readily be obtained at a reduction of 50 per cent. as compared with that of the best type of ordinary gas burner. Already there are signs that the great failing of these burners—viz., the fragility of the mantle—is likely to be overcome, patents having been secured for the construction of a mantle with a platinum woven base, which it is stated can be readily handled without fear of fracture or injury. If such a mantle is available, it is clear that a great revolution may take place in gas manufacture, since it would no longer be necessary to supply a luminous gas. It has already been discovered that in some towns half the total gas consumption takes place during the hours of daylight—for motive, cooking and other purposes. This gas is used at great disadvantage, since a non-luminous gas, made at much lower cost, would be quite as suitable. If the incandescent burner became practicable for all lighting purposes, it is clear that a non luminous gas which would meet all requirements could be sent out for about 1s. per 1,000 cubic feet. Such a reduction in price would, no doubt, be followed by an enormously increased use of gas for motive and fuel purposes generally. In a paper recently contributed to this Society, entitled "The Public Supply of Electrical Energy—its Cost and Price," a comparison was set up between the cost of a 16 candle power gas light in Liverpool, with gas at 3s. 4d. per 1,000 cubic feet, and that of a 16 candle power incandescent electric light—the former being shown at 0.2d., and the latter at 0.4d. per hour; and the hope was expressed that within a reasonable time electrical energy would be supplied at such a price as to reduce the cost of the incandescent electric light to that of gas. If the comparison had been made with Liverpool gas used with the incandescent gas burner, the relative prices for maintaining a 16 candle power light, or its equivalent, would have read: Gas, 0 03d.; electricity, 0.4d.—showing that an incandescent gas light can be obtained at $\frac{1}{13}$ the cost of an incandescent electric light. This may be taken as a fair comparison, seeing that the cost of maintaining the lamps in both cases would be about equal. The incandescent gas burner may be said to mark the extent of the progress that has been made up to the present in the construction of apparatus for developing light from coal gas.

Development of the Incandescent Electric Lamp.

By Mr. John W. Howell, in *Engineering Magazine.*

The incandescent lamp, though in such common use to day, has been before the public only about 14 years. The causes underlying the rapid growth in its use were the great demand for the light, which grew steadily as its peculiar advantages became better known, and the interest which was awakened in the minds of many workers by the problems which arose in great numbers in connection with the lamp itself and with the apparatus and appliances made necessary by its introduction into new fields. The development of incandescent lighting has called for the best efforts of master minds in many departments of scientific and technical investigation, and the attractiveness of the work has kept the interest of the workers keenly alive.

The incandescent lamp produces light without flame and with very little heat, with no consumption of oxygen or production of undesirable products, and with an utter disregard for surrounding conditions. These qualities render the incandescent lamp peculiarly suited for lighting very many places where other lights are inconvenient or dangerous. Thus it can be used in the presence of explosive gases or ignitible substances, as in coal mines, oil refineries, chemical works, and powder mills. In cotton and woolen mills and other factories where the product is at times in an easily ignitible condition; this lamp can be used in closer proximity to the work than can a flaming lamp.

The comparative absence of heat, besides being a blessing to all users in hot weather, is of special value to dentists and surgeons. The fact that the lamps consume no oxygen, thus yielding no disagreeable products, renders them peculiarly suitable for use on vessels where ventilation is often a difficult problem. Their adaptability is another cause of their popularity. The advent of these lamps has rendered artistic and decorative lighting possible. Who has not looked into a show window lighted with concealed lamps and admired the effect? How many people have spent an hour in the dining room at the Waldorf Hotel in New York without noticing that the candles on the tables were indeed candles, while the candles on the walls were miniature incandescent lamps?

People are so accustomed to the beautiful and wonderful adaptation of incandescent lamps that they evince surprise at nothing, and satisfy their minds with the explanation that it is done by electricity—a magic word that explains all mysteries and makes everything possible. It has indeed rendered possible many achievements impossible without it, but the work has been done by man, aided by electricity, and not by electricity aided by man. It is a man's servant by conquest; not nature's gift to the indolent.

Volta's discovery of the battery, in 1800, placed at man's disposal a new form of energy, which at once received the attention of investigators. The transformation of electric energy to the other well-known forms was soon accomplished, and heat, light and mechanical power were produced from electricity.

Sir Humphry Davy, in 1808, constructed a very large battery. In his experiments he produced the electric arc between carbon points, and electrically heated to incandescence platinum and other wires, and carbon. The effects produced by the new and invisible form of energy were subjects of much investigation. Metallic wires and pieces of carbon were heated to incandescence in the open air, and in globes which were exhausted, or filled with different gases at various pressures.

Very early in the history of the subject we had in name, but in name only, all the elements which enter into the modern incandescent lamp. We had the carbon burner, the vacuum, and the glass globe with its leading in conductors. While these elements existed in name in the apparatus made by Davy, they did not exist in the perfection necessary for a successful incandescent lamp. The best vacuum obtained at that time was not a vacuum in the sense in which the word is used in connection with the incandescent lamps to day. The globe which contained Davy's incandescent carbon was not suitable for the protection of a vacuum under the conditions of use as an incandescent lamp. The carbon conductors which Davy heated to incandescence would not have proved durable for any great length of time.

There are four essentials in the successful modern incandescent lamp: the vacuum, the glass globe, the carbon burner, and the conductors which carry the current through the globe. All these elements existed in name in the apparatus of Davy. The development of the lamp has not called for the discovery or introduction of any new element; it is simply the development of the elements which existed in Davy's apparatus, and their arrangement in a combination in which the laws governing them and their relations to one another are appreciated and intelligently applied. The large battertes, which were the sources of currents employed by Davy, were expensive to make and maintain, and were to be found only in a few large and well-equipped laboratories. Soon new forms of batteries were discovered, and the magneto electric machine was invented, cheapening the production of currents.

Practical and commercial applications of the new phenomena are the subjects of the patents which form so large a part of the records of the history of electric lighting. From the lamp patented by Starr in 1845 to the lamp of Sawyer and Man in 1879 very little progress was made toward the final solution of the problem, except in the carbon burner. The extreme simplicity which characterizes the modern incandescent lamp, and to which its success was largely due, was more nearly approached in the Starr lamp than in many subsequent lamps.

Starr's lamp is worthy of special attention. The carbon burner was contained in a bulb blown on the end of a barometer tube. This bulb and tube were filled with mercury, and air and moisture were driven out as was done in making barometers. The tube was then inverted in a cup of mercury, leaving a Torricellian vacuum in the bulb at the top of the tube. One of the conductors which carried the current to the burner was a platinum wire sealed in the top of the bulb by fusion of the glass. The other conductor was a wire which dipped into the mercury in the tube. The support for the burner was a simple piece of insulating material.

Let us study in this lamp the four elements whose development we are tracing. The carbon burner was made of gas retort carbon, which, although difficult to make into thin pieces, is a very hard and dense carbon. It was the best carbon known to the art at that time; indeed, its nature is similar to that of the carbon deposited on modern filaments by the hydrocarbon treatment. The glass bulb was a simple one. It was made of thin glass, which was advantageous. The open end was closed by mercury more tightly than many subsequent lamps were closed. The one platinum conductor which was sealed in the glass illustrates the method of carrying the current into the lamp which is in almost universal use to day.

The Torricellian vacuum in this lamp was at that time considered a perfect vacuum, and was a practically good vacuum until the lamp was operated. But when the lamp was burned gases were driven by the heat from the interior parts of the lamp, which impaired the vacuum and soon rendered the lamp useless. The lamp, when in use, was still attached to the barometric tube by means of which it had been exhausted, and when the lamp was operated the depression of the mercury in this tube showed that gases were liberated within the lamp. This was a fatal defect, and the method of exhausting offered no remedy for it. Modern lamps are exhausted by means of vacuum pumps which draw from the lamp chambers all air and other gases. When the air has been withdrawn, the lamps, being still connected with the pumps, are burned and the gases, liberated by the heat, are drawn from them by the pumps.

The difficulty of producing a vacuum good enough to render carbon stable at a high incandescence caused many inventors to prefer platinum as the material from which to make the burners of their lamps. It also led to the invention of several lamps in which the carbon, when consumed by the air necessarily remaining in the lamp, was replaced automatically by another. Some of these lamps had several carbons. The lamp patented by Konn in 1875 was of this type, and was probably the most successful lamp made up to that time. It had five carbons. This lamp had a limited commercial use. The first carbon was consumed almost immediately when put in use, and each subsequent carbon lasted about two hours. The mechanism in these lamps increased the amount of gas liberated in the lamp by the heat, and increased the difficulty it was intended to remedy.

The consumption of carbon in the best vacuum that could be produced led many inventors to fill lamp chambers with a gas which would not combine with the incandescent carbon. The lamps made by Sawyer and Man in 1879 were filled with nitrogen gas. These lamps, during process of filling, were burned, while this gas was passed in a stream through them, and the gases liberated in the interior of the lamps by the heat were washed out and the lamp chamber left full of nitrogen. The heat conducting power of this gas caused these lamps to get heated, and means of cooling them had to be found.

Every lamp before 1878 was made in separate parts. This construction was made necesssary by the short life of the burners, which necessitated their frequent removal, and by the liability of the mechanism to get out of order. The parts of these lamps were cemented and clamped together, and methods of making such joints tight were subjects of invention. Before this time pumps had been invented which were capable of producing a nearly perfect vacuum, but incandescent lamp inventors had not availed themselves of them.

The best lamps produced up to 1879 had two features which rendered them unsuited to the maintenance of a high vacuum. The large amount of mechanism which they contained would liberate gases when the lamps were burned; and the joints between the separable parts of the lamp were almost of necessity a source of trouble from leakage, as it was difficult to make such joints tight in a structure which was heated and cooled frequently. Thus the two lines which had been followed by inventors in their efforts to remedy the evil effects of an insufficient vacuum had removed the lamp chambers further and further from the simple all-glass bulb which characterizes the successful lamp of to-day.

When we consider that all inventors, whether they used a series of burners or one burner in a lamp having a vacuum or containing an inert gas, recognized the necessity of making the lamps in separable parts, we admire the boldness of Mr. Edison in reducing the lamp to elementary simplicity, putting inside the lamps nothing but the carbon burner and short conducting wires, and making the chamber entirely of glass sealed at all points by fusion. Such a lamp chamber would maintain a vacuum. There is no joint in this lamp at which leakage can occur, and the leading-in conductors are sealed into the glass so that no leakage can occur where they enter. They cannot be taken apart to put in new burners; consequently they must burn so long that when they do break the user is satisfied to throw them away.

Having traced the development of the lamp chamber, let us consider the carbon burner. The early experimenters naturally used pieces of charcoal, which was readily consumed, as it oxidizes at a low temperature. Pieces of gas retort carbon were found to be more durable, and Starr used the latter in his lamp. It is hard to work to the desired size, but is denser and harder than charcoal and requires a higher temperature to oxidize it. The difficulty of making these burners led experimenters to devise methods of making artificial burners. In 1857 Charles W. Harrison made carbon burners by suspending pencils of charcoal in a retort which was filled with gas and heated to a high heat. This deposited a layer of gas carbon on the charcoal, which made it very hard. This process was also used by Sidot in 1870 and by Gaudoin in 1877. Gaudoin also made carbon burners by carbonizing pieces of wood of the shape and size desired, which were soaked in syrup, and recarbonized, several times. Carre, in 1876, made carbon rods and pen-

cils by grinding different kinds of carbon together, mixing with syrup, molding and baking. He baked these carbon rods several times, soaking them in hot syrup before each baking. In 1879 Sawyer and Man immersed their carbon burners in a "carbon liquid" and heated them electrically while so immersed. This process deposits upon the burner a layer of very hard carbon. This is the best method known for making burners for incandescent lamps, and nearly all burners used to day are finished by this process. The carbon burners used to-day upon which this treatment is applied are chiefly made of (1) silk threads, treated to harden them; (2) bamboo cut to the desired size; or (3) cellulose, which is dissolved, treated chemically, and made into pieces of the desired size. Each of these materials must be reduced to carbon by baking at a high temperature. The advantage which one of these may have over another lies in their adaptability and the ease with which they may be made of the desired size. Many filaments used to day are only $\frac{5}{1000}$ of an inch in diameter, and to make such filaments in large quantities requires a base material which is homogeneous, and which can be conveniently carried through the necessary processes of manufacture. Filaments made of chemically prepared cellulose, or of bamboo, have been used with fair success without being treated by the carbon depositing process, but this process is necessary to secure the best results from any carbon base.

This process is beneficial in three ways: it coats the base with a layer of very hard, dense and stable carbon; it brings all the burners to a predetermined resistance, and it deposits gray carbon, which is a worse radiator of heat than is any other form of carbon which has been used for filaments of incandescent lamps.

The amount of light which a given burner yields in an incandescent lamp depends upon its temperature. The efficiency of the lamp depends upon the amount of energy which must be constantly supplied to the burner to maintain its temperature. The worse the heat radiating power of any burner, the less rapidly it is cooled by radiation, and the less the energy necessary to maintain its temperature or candle power, as the energy supplied must equal the energy dissipated. The efficiency of a given burner depends upon the amount of surface which yields each unit of light—the greater the surface per unit of light the less the efficiency.

Consider two burners of the same size, one having been treated and the other not. The treated burner, being the worse radiator, will yield a given amount of light with less energy or at a greater efficiency than the non-treated one. Consequently, if a treated and an untreated burner are to be made of the same candle power and efficiency, the treated burner must have a larger surface than the untreated one. Assuming that two burners are at the same temperature when they are yielding the same amount of light per unit of surface, we conclude that a treated burner is operated at a lower temperature than an untreated one at the same efficiency. And, being at a lower temperature, it should give a longer life, be more stable, and maintain its candle power better. Thus the hydrocarbon treatment increases the stability of a burner by reason of the character of the surface which it gives, as well as by the hardness and density of the deposited carbon.

This deposited carbon has a much lower specific resistance than any other form of carbon available for incandescent lamp filaments. This is a great advantage in making low resistance burners and a disadvantage in making high resistance ones.

The inventor of the hydrocarbon treatment process did not understand that a bad radiating surface was desirable, but urged the good radiating power of carbon as one of its advantages over platinum. In 1879, Alfred Niaudet, a French physicist of deservedly high repute, compared the radiating power of carbon and platinum, to the detriment of the latter, for use in incandescent lamps. In 1874, Wild, the director of the Russian imperial observatory, made the same comparison and drew the same conclusion. Exactly the opposite is the fact. If a stable coating of bright platinum could be applied to a carbon burner, it would be better in this respect than the coating given by the hydrocarbon treatment.

Thus far we have considered the incandescent lamp as an apparatus for converting electricity into light, without any reference to its relation to the system of distribution by which the lamps are supplied with current. With the exception of Lane Fox, no inventor of lamps prior to Edison appears to have considered the qualities which successful distribution require in a lamp. No carbon burner lamp, before Edison made his, had that characteristic so essential to multiple arc distribution—namely, high resistance. The lines along which inventors previous to Edison had traveled precluded the possibility of their making high resistance carbon burner lamps. No lamp chamber used by them was capable of successfully maintaining the high vacuum necessary to render filamentary high resistance burners stable. The short, thick carbon burners which they used wasted away quite rapidly, and certainly a filamentary burner would have been consumed in a short time. Reasoning with a knowledge of the performance of lamps previous to Edison's, any one would be justified in pronouncing a filamentary burner a probable failure. Indeed, Edison's filamentary burner was made possible by Edison's all glass lamp chamber. There was practically no superfluous material in it to give off gases. Being closed at all points by the fusion of the glass, it would protect a vacuum indefinitely, and the duration of the lamp in use was limited by the stability of the carbon burner. The tendency of invention from Star to Sawyer and Man had been to fill the lamp chamber with mechanism. Edison went directly to the root of the matter, stripping the lamp of all unessential parts. The lamp made by Edison in 1880 and the lamp made to day are different in details of manufacture only. Their appearance and general characteristics are the same.

An incandescent lamp is simply an apparatus for converting electricity into light. The laws which govern the lamp are the well known laws of heat, light and electricity. No new law has been discovered in connection with incandescent lamps. Edison was, I believe, the first to correlate these laws and to make a lamp which, because of its harmony with these laws, was stable.

The multiple arc system of distribution is the ideal one for operating incandescent lamps. It was by making his lamp of such high resistance and such small radiating surface that it could be used on such a system that Edison made his lamp a commercial success. But if we consider the lamp without any reference to any system of distribution, a very high resistance lamp is inferior to one of lower resistance. The systems of distribution in general use to-day use lamps of two general voltages—115 and 55. The 115 volt lamps are of very high resistance. The 55-volt lamps are of lower resistance, and are superior to the 115-volt lamps. When this fact is more fully appreciated lower voltage lamps will be more generally used. By using lower voltage lamps we can get the benefit of the advantages of the increased stability which these lamps have, and this will enable us to use lamps of fewer watts per candle than are required by the higher voltage lamps.

The greatest development of the lamp since 1880 has been in its efficiency. The first lamps commercially installed by the Edison Company required 6 watts per candle to operate them, whereas now well regulated stations use lamps requiring only 3 watts per candle; thus each horse power produces twice as much light now as it could have produced in 1880. Progress is still being made in this direction. Every improvement in the quality of a lamp allows it to be operated at a higher efficiency, and it is in this direction that we look for future improvements.

Gas and the Electric Light.

[By Mr. W. J. Dibdin, F.I.C., F.C.S., in the *Journal of Gas Lighting*.]

The electric light, like gas light, is an evolution of scientific discovery which has been in active progress during the whole of this century. Essentially produced by the transmission of energy through either chemical or mechanical means, this energy may be derived from a natural force—as, for instance, a waterfall—or by the combustion of a material in the cells of a voltaic battery, or fuel in a furnace. The energy being converted into electric current may be used to manifest electric light by passing between carbon points, or by rendering incandescent solid bodies such as carbon, platinum, or iridium, etc. Sir Humphry Davy, in 1810, established the fact that, by means of a battery of 2,000 plates connected by wires to charcoal points, a bright spark was emitted on these points being brought into contact; and by withdrawing them to a distance of 4 inches a constant electrical discharge took place—forming a most brilliant arc of light. On closely examining this arc, Davy found that there was a constant transferrence of particles of carbon from one electrode to the other, and that the light was due to the incandescence of these particles owing to the intense heat to which they were raised by the electric current. But, as Mr. Denny Lane, in his address to the Gas Institute last year, said—

"In the generation of electricity from mechanical force, an enormous advance has been made since the time when, over 80 years ago, this 'new planet' first 'swam into the ken' of the great philosopher; and what is most remarkable is the fact that this marvelous growth was derived from two small laboratory experiments. First of all Oersted, in 1819, discovered that a magnetic needle suspended on a pointed pivot was deflected if an electric current was passed through a wire in its vicinity, and parallel to it; and thus electricity produced mechanical movement. It seems strange that no one thought of trying the con-

verse—namely, whether moving the magnet mechanically would produce a current in the wire—until 1831, when Faraday made his great discovery that, in a conductor moved into or out of a magnetic field, a momentary current was produced as it crossed what he called the 'lines of force.' Everything that has been done since then by Siemens, Gramme, Wilde, Wheatstone, Ladd and others is but the natural growth of the seed that germinated in the fertile soil of Oersted's and Faraday's intelligence. And what a growth it has been! The telegraph, the electric light and traction, and the transference of power for over 100 miles, conversations carried on between two people separated by 1,000 miles, electro metallurgy, the separation of rare metals from their matrices, and the thousand offices performed by this deft and willing servant of man. When your practical man scoffs at what he calls the toys of science, let him reflect on the momentous issues of these two simple experiments. In the whole history of practical science nothing is so amazing as the development of dynamo electric energy."

Naturally, the first development of the electric light was in the form of arc lamps; these being all mere modifications, for the purpose of making the light continuous, of Davy's original carbon points. Among the first of those which, some 14 years back, began to be used for general illumination, was that of Jablochkoff, who arranged the two carbons parallel to one another, and made use of an alternating current for the purpose of insuring the equal consumption of the two points. This light was first extensively tried in Paris, and it was the first system publicly used in London, where it was employed for illuminating the Thames Embankment from Westminster to Blackfriars Bridge. Subsequently Brush improved the regulating arc lamp, and he was rapidly followed by many others, whose improved forms of lamps are now so generally adopted. At the time the Thames Embankment experiments were commenced—in 1880—the great difficulty experienced was the distribution of the light, instead of concentrating it at a few points where illumination was intense, leaving large spaces between insufficiently lighted; and many were the suggestions for bringing about this object. The difficulty was speedily met, however, by the introduction of the incandescent lamp. By the simple expedient of raising a carbon filament in vacuo to a white heat, by its resistance to the passage of the current, the electric light at once leaped into popular favor, until it has now taken its place as the fashionable illuminant of the day.

Before leaving the arc lamp it may be interesting to state that the so-called 1,000 candle power Jablochkoff "candles" were, in reality, equal to only 460 candles for the naked light, and were reduced to 150 candles by the use of opal globes, or to 265 candles when glass "frosted" globes were employed. Various measurements by the writer of other arc lamps showed a similar reduction from the electricians' estimate of illuminating power. It has always been a matter for regret that the commercial introduction of the electric light, both arc and incandescent, should have been accompanied by such an unnecessary and wanton exaggeration of the truth in this respect; and it is to be sincerely hoped that, in the near future, the advantages of this form of illumination will be heralded in terms as true as the light itself is beautiful.

Before passing on to the subject of relative cost, etc., it will be convenient here to consider the basis upon which the value of the electric current, and consequently of light and power, is fixed. The Board of Trade unit is accepted in this country as the unit for price. This expression indicates the quantity of the current, expressed in amperes, multiplied by the intensity expressed in volts. So that either 1,000 amperes × 1 volt, or 1 ampere × 1,000 volts, or 100 amperes × 10 volts, etc., represents a flow of electric energy equal to 1,000 watts; and this 1,000 watts, or 1 kilowatt, acting during one hour, equals one Board of Trade unit. It will therefore be obvious that if we know the quantity (amperes) and intensity (volts) required to yield a given volume of light, we can at once find the total light obtainable per Board of Trade of unit, and consequently the cost, provided the price per unit is fixed.

No little controversy has arisen around the relative merits of high-pressure and low-pressure supplies. It is evident that if the intensity, or voltage, be increased in proportion to the quantity, or amperes, a larger amount of electric energy can be forced through a given sized wire; and much has been made of the presumed advantages of such a system. Unfortunately, however, the advantage in the first cost of cables is counterbalanced by the necessity for employing means to reduce the intensity of the current before it can be used for domestic purposes. The instruments used for this purpose are known as transformers. Another disadvantage of high-pressure supplies is the danger to life by persons coming in contact with the wires, and from the liability, in the case of bad connections, to casualties from overheating and fire. For these reasons the tendency is decidedly towards continuous current low-pressure installations.

Thus far about the electric light. It will now be advisable to consider, for comparison, the elementary conditions affecting the supply and use of gas. In order to study the question from this point of view, it will be unnecessary to review the history of gas, but to accept its present well understood position as a commercial undertaking. In order to utilize gaseous matter either as a fuel or as a light giver, it, like electrical energy, must be conveyed from the point of generation to that where it is to be utilized. Electricity is conveyed by wires or copper bands; gas is pushed through a pipe. If we want to pass more gas through a given sized pipe, we must send it at a greater pressure; but if the pressure cannot be increased, we must use a larger pipe. It will therefore be seen that, in order to obtain more luminous energy, we must use a larger quantity of gas; but that quantity is unavailable unless it has sufficient pressure behind it to cause it to pass through the orifice of the burner, just as the electric current must have sufficient voltage or pressure to enable it to overcome the resistance of the carbon, and so raise it to its light-giving temperature. We may thus consider that, in the transmission of gaseous and electrical energy, respectively, the size of pipes and pressure in the first instance may be compared with the carrying capacity of the wires (in amperes) and the pressure of current (in volts).

In considering the quality of the gas, we not alone look at the pressure measured, in inches, by the height of a column of water supported by it, but at its actual composition, in regard to the quantity of light which a given volume of gas is capable of affording when burnt under certain specified conditions. This quality of the gas is known as its illuminating power. Now, what is the equivalent property pertaining to electrical energy? It is the pressure or voltage; because, although the quantity of current at which it is supplied may be constant, any falling off in the pressure is followed by a far more rapid diminution of the light given by any specified lamp. Thus, a 16 candle power lamp was found to give 15.03 candles when the current indicated 99.33 volts, and 0 628 amperes 62.38 watts. When the voltage fell from 99 to 96, the loss in candle power was from 15 to 10.9, or 27.3 per cent., while when it fell to 90 the loss was exactly 50 per cent. But the number of watts (volts and amperes) by which the value of the current to the consumer is estimated did not fall in proportion, but only from 62 to 56½, or about 9 per cent. The great importance of the voltage being kept fully up to the standard point is, indeed, of far more consequence to the consumer than is that of the illuminating power of the gas being equally up to its standard; and wherever an installation of the electric light is introduced, the suppliers should be under most stringent regulations as to the voltage of the supply.

The means by which the energy, either gaseous or electrical, are to be utilized next invite consideration. These are: (1) Burners, which may be divided into two classes—viz., ordinary, such as flat-flames, Argands, etc., and recuperative, such as the Wenham, and others of that type first introduced by Herr F. Siemens. (2) Electric lamps, which may be also divided into two classes—viz., incandescent and arc lamps. For our purposes we may compare ordinary flatflame, etc., gas burners with incandescent lamps, and recuperative burners with arc lamps. Before making actual comparisons it will be well to consider the relative merits of each system, and fix the basis upon which it may be taken.

Good Argand burners will, with 16 candle gas, give from 16 to 17½ candles of light under the best conditions. But flat flame burners, at their best, will not give more than 15 candles of light; while a large number of inferior burners, used under the worst imaginable conditions, will not furnish more than 10 or 11 candles. We may therefore assume that, under normal conditions, in the majority of well regulated establishments, such as those wherein the electric light is most likely to be adopted, an all-round average of 14 candles per 5 cubic feet of gas per hour of 16-candle gas may be taken as fairly representing the truth. The average luminous energy per reputed 16 candle power incandescent electric lamp is about 13 candles; the watts being 59. Now, as the Board of Trade unit is 1,000 watts acting for one hour, we have an exact means for comparing cost. But, in order not to do anything to overstate the case, let it be assumed that the actual average light per 5 cubic feet of gas in ordinary burners is equal to only 13 instead of 14 candles. Then on this basis we have 59 watts giving 13 candles = 1,000 watts giving 220 candles per hour. On the other hand, if 5 cubic feet of gas burning during one hour yield 13 candles, 1,000 cubic feet will give 2,600 candles. If the price of the electric energy per Board of Trade unit is 6d., then the cost of 2,600 candles (= 1,000 cubic feet of gas) will be 5s. 11d. But here we are making an assumption of a startling character. We have taken the initial and not the working intensity of the incandescent lamp. Such a lamp, having an initial intensity of 14.8 candles, may, after 100 hour's work, fall to 14 candles; after 250 hours,

cils by grinding different kinds of carbon together, mixing with syrup, molding and baking. He baked these carbon rods several times, soaking them in hot syrup before each baking. In 1879 Sawyer and Man immersed their carbon burners in a "carbon liquid" and heated them electrically while so immersed. This process deposits upon the burner a layer of very hard carbon. This is the best method known for making burners for incandescent lamps, and nearly all burners used to day are finished by this process. The carbon burners used to-day upon which this treatment is applied are chiefly made of (1) silk threads, treated to harden them; (2) bamboo cut to the desired size; or (3) cellulose, which is dissolved, treated chemically, and made into pieces of the desired size. Each of these materials must be reduced to carbon by baking at a high temperature. The advantage which one of these may have over another lies in their adaptability and the ease with which they may be made of the desired size. Many filaments used to day are only $\frac{5}{1000}$ of an inch in diameter, and to make such filaments in large quantities requires a base material which is homogeneous, and which can be conveniently carried through the necessary processes of manufacture. Filaments made of chemically prepared cellulose, or of bamboo, have been used with fair success without being treated by the carbon depositing process, but this process is necessary to secure the best results from any carbon base.

This process is beneficial in three ways: it coats the base with a layer of very hard, dense and stable carbon; it brings all the burners to a predetermined resistance, and it deposits gray carbon, which is a worse radiator of heat than is any other form of carbon which has been used for filaments of incandescent lamps.

The amount of light which a given burner yields in an incandescent lamp depends upon its temperature. The efficiency of the lamp depends upon the amount of energy which must be constantly supplied to the burner to maintain its temperature. The worse the heat radiating power of any burner, the less rapidly it is cooled by radiation, and the less the energy necessary to maintain its temperature or candle power, as the energy supplied must equal the energy dissipated. The efficiency of a given burner depends upon the amount of surface which yields each unit of light—the greater the surface per unit of light the less the efficiency.

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The inventor of the hydrocarbon treatment process did not understand that a bad radiating surface was desirable, but urged the good radiating power of carbon as one of its advantages over platinum. In 1879, Alfred Niaudet, a French physicist of deservedly high repute, compared the radiating power of carbon and platinum, to the detriment of the latter, for use in incandescent lamps. In 1874, Wild, the director of the Russian imperial observatory, made the same comparison and drew the same conclusion. Exactly the opposite is the fact. If a stable coating of bright platinum could be applied to a carbon burner, it would be better in this respect than the coating given by the hydrocarbon treatment.

Thus far we have considered the incandescent lamp as an apparatus for converting electricity into light, without any reference to its relation to the system of distribution by which the lamps are supplied with current. With the exception of Lane Fox, no inventor of lamps prior to Edison appears to have considered the qualities which successful distribution require in a lamp. No carbon burner lamp, before Edison made his, had that characteristic so essential to multiple arc distribution—namely, high resistance. The lines along which inventors previous to Edison had traveled precluded the possibility of their making high resistance carbon burner lamps. No lamp chamber used by them was capable of successfully maintaining the high vacuum necessary to render filamentary high resistance burners stable. The short, thick carbon burners which they used wasted away quite rapidly, and certainly a filamentary burner would have been consumed in a short time. Reasoning with a knowledge of the performance of lamps previous to Edison's, any one would be justified in pronouncing a filamentary burner a probable failure. Indeed, Edison's filamentary burner was made possible by Edison's all glass lamp chamber. There was practically no superfluous material in it to give off gases. Being closed at all points by the fusion of the glass, it would protect a vacuum indefinitely, and the duration of the lamp in use was limited by the stability of the carbon burner. The tendency of invention from Star to Sawyer and Man had been to fill the lamp chamber with mechanism. Edison went directly to the root of the matter, stripping the lamp of all unessential parts. The lamp made by Edison in 1880 and the lamp made to day are different in details of manufacture only. Their appearance and general characteristics are the same.

An incandescent lamp is simply an apparatus for converting electricity into light. The laws which govern the lamp are the well known laws of heat, light and electricity. No new law has been discovered in connection with incandescent lamps. Edison was, I believe, the first to correlate these laws and to make a lamp which, because of its harmony with these laws, was stable.

The multiple arc system of distribution is the ideal one for operating incandescent lamps. It was by making his lamp of such high resistance and such small radiating surface that it could be used on such a system that Edison made his lamp a commercial success. But if we consider the lamp without any reference to any system of distribution, a very high resistance lamp is inferior to one of lower resistance. The systems of distribution in general use to-day use lamps of two general voltages—115 and 55. The 115 volt lamps are of very high resistance. The 55-volt lamps are of lower resistance, and are superior to the 115-volt lamps. When this fact is more fully appreciated lower voltage lamps will be more generally used. By using lower voltage lamps we can get the benefit of the advantages of the increased stability which these lamps have, and this will enable us to use lamps of fewer watts per candle than are required by the higher voltage lamps.

The greatest development of the lamp since 1880 has been in its efficiency. The first lamps commercially installed by the Edison Company required 6 watts per candle to operate them, whereas now well regulated stations use lamps requiring only 3 watts per candle; thus each horse power produces twice as much light now as it could have produced in 1880. Progress is still being made in this direction. Every improvement in the quality of a lamp allows it to be operated at a higher efficiency, and it is in this direction that we look for future improvements.

Gas and the Electric Light.

[By Mr. W. J. Dibdin, F.I.C., F.C.S., in the *Journal of Gas Lighting*.]

The electric light, like gas light, is an evolution of scientific discovery which has been in active progress during the whole of this century. Essentially produced by the transmission of energy through either chemical or mechanical means, this energy may be derived from a natural force—as, for instance, a waterfall—or by the combustion of a material in the cells of a voltaic battery, or fuel in a furnace. The energy being converted into electric current may be used to manifest electric light by passing between carbon points, or by rendering incandescent solid bodies such as carbon, platinum, or iridium, etc. Sir Humphry Davy, in 1810, established the fact that, by means of a battery of 2,000 plates connected by wires to charcoal points, a bright spark was emitted on these points being brought into contact; and by withdrawing them to a distance of 4 inches a constant electrical discharge took place—forming a most brilliant arc of light. On closely examining this arc, Davy found that there was a constant transferrence of particles of carbon from one electrode to the other, and that the light was due to the incandescence of these particles owing to the intense heat to which they were raised by the electric current. But, as Mr. Denny Lane, in his address to the Gas Institute last year, said—

"In the generation of electricity from mechanical force, an enormous advance has been made since the time when, over 80 years ago, this 'new planet' first 'swam into the ken' of the great philosopher; and what is most remarkable is the fact that this marvelous growth was derived from two small laboratory experiments. First of all Oersted, in 1819, discovered that a magnetic needle suspended on a pointed pivot was deflected if an electric current was passed through a wire in its vicinity, and parallel to it; and thus electricity produced mechanical movement. It seems strange that no one thought of trying the con-

verse—namely, whether moving the magnet mechanically would produce a current in the wire—until 1831, when Faraday made his great discovery that, in a conductor moved into or out of a magnetic field, a momentary current was produced as it crossed what he called the 'lines of force.' Everything that has been done since then by Siemens, Gramme, Wilde, Wheatstone, Ladd and others is but the natural growth of the seed that germinated in the fertile soil of Oersted's and Faraday's intelligence. And what a growth it has been! The telegraph, the electric light and traction, and the transference of power for over 100 miles, conversations carried on between two people separated by 1,000 miles, electro metallurgy, the separation of rare metals from their matrices, and the thousand offices performed by this deft and willing servant of man. When your practical man scoffs at what he calls the toys of science, let him reflect on the momentous issues of these two simple experiments. In the whole history of practical science nothing is so amazing as the development of dynamo electric energy."

Naturally, the first development of the electric light was in the form of arc lamps; these being all mere modifications, for the purpose of making the light continuous, of Davy's original carbon points. Among the first of those which, some 14 years back, began to be used for general illumination, was that of Jablochkoff, who arranged the two carbons parallel to one another, and made use of an alternating current for the purpose of insuring the equal consumption of the two points. This light was first extensively tried in Paris, and it was the first system publicly used in London, where it was employed for illuminating the Thames Embankment from Westminster to Blackfriars Bridge. Subsequently Brush improved the regulating arc lamp, and he was rapidly followed by many others, whose improved forms of lamps are now so generally adopted. At the time the Thames Embankment experiments were commenced—in 1880—the great difficulty experienced was the distribution of the light, instead of concentrating it at a few points where illumination was intense, leaving large spaces between insufficiently lighted; and many were the suggestions for bringing about this object. The difficulty was speedily met, however, by the introduction of the incandescent lamp. By the simple expedient of raising a carbon filament in vacuo to a white heat, by its resistance to the passage of the current, the electric light at once leaped into popular favor, until it has now taken its place as the fashionable illuminant of the day.

Before leaving the arc lamp it may be interesting to state that the so-called 1,000 candle power Jablochkoff "candles" were, in reality, equal to only 460 candles for the naked light, and were reduced to 150 candles by the use of opal globes, or to 265 candles when glass "frosted" globes were employed. Various measurements by the writer of other arc lamps showed a similar reduction from the electricians' estimate of illuminating power. It has always been a matter for regret that the commercial introduction of the electric light, both arc and incandescent, should have been accompanied by such an unnecessary and wanton exaggeration of the truth in this respect; and it is to be sincerely hoped that, in the near future, the advantages of this form of illumination will be heralded in terms as true as the light itself is beautiful.

Before passing on to the subject of relative cost, etc., it will be convenient here to consider the basis upon which the value of the electric current, and consequently of light and power, is fixed. The Board of Trade unit is accepted in this country as the unit for price. This expression indicates the quantity of the current, expressed in amperes, multiplied by the intensity expressed in volts. So that either 1,000 amperes × 1 volt, or 1 ampere × 1,000 volts, or 100 amperes × 10 volts, etc., represents a flow of electric energy equal to 1,000 watts; and this 1,000 watts, or 1 kilowatt, acting during one hour, equals one Board of Trade unit. It will therefore be obvious that if we know the quantity (amperes) and intensity (volts) required to yield a given volume of light, we can at once find the total light obtainable per Board of Trade of unit, and consequently the cost, provided the price per unit is fixed.

No little controversy has arisen around the relative merits of high-pressure and low-pressure supplies. It is evident that if the intensity, or voltage, be increased in proportion to the quantity, or amperes, a larger amount of electric energy can be forced through a given sized wire; and much has been made of the presumed advantages of such a system. Unfortunately, however, the advantage in the first cost of cables is counterbalanced by the necessity for employing means to reduce the intensity of the current before it can be used for domestic purposes. The instruments used for this purpose are known as transformers. Another disadvantage of high-pressure supplies is the danger to life by persons coming in contact with the wires, and from the liability, in the case of bad connections, to casualties from overheating and fire. For these reasons the tendency is decidedly towards continuous current low-pressure installations.

Thus far about the electric light. It will now be advisable to consider, for comparison, the elementary conditions affecting the supply and use of gas. In order to study the question from this point of view, it will be unnecessary to review the history of gas, but to accept its present well understood position as a commercial undertaking. In order to utilize gaseous matter either as a fuel or as a light giver, it, like electrical energy, must be conveyed from the point of generation to that where it is to be utilized. Electricity is conveyed by wires or copper bands; gas is pushed through a pipe. If we want to pass more gas through a given sized pipe, we must send it at a greater pressure; but if the pressure cannot be increased, we must use a larger pipe. It will therefore be seen that, in order to obtain more luminous energy, we must use a larger quantity of gas; but that quantity is unavailable unless it has sufficient pressure behind it to cause it to pass through the orifice of the burner, just as the electric current must have sufficient voltage or pressure to enable it to overcome the resistance of the carbon, and so raise it to its light-giving temperature. We may thus consider that, in the transmission of gaseous and electrical energy, respectively, the size of pipes and pressure in the first instance may be compared with the carrying capacity of the wires (in amperes) and the pressure of current (in volts).

In considering the quality of the gas, we not alone look at the pressure measured, in inches, by the height of a column of water supported by it, but at its actual composition, in regard to the quantity of light which a given volume of gas is capable of affording when burnt under certain specified conditions. This quality of the gas is known as its illuminating power. Now, what is the equivalent property pertaining to electrical energy? It is the pressure or voltage; because, although the quantity of current at which it is supplied may be constant, any falling off in the pressure is followed by a far more rapid diminution of the light given by any specified lamp. Thus, a 16 candle power lamp was found to give 15.03 candles when the current indicated 99.33 volts, and 0 628 amperes 62.38 watts. When the voltage fell from 99 to 96, the loss in candle power was from 15 to 10.9, or 27.3 per cent., while when it fell to 90 the loss was exactly 50 per cent. But the number of watts (volts and amperes) by which the value of the current to the consumer is estimated did not fall in proportion, but only from 62 to 56½, or about 9 per cent. The great importance of the voltage being kept fully up to the standard point is, indeed, of far more consequence to the consumer than is that of the illuminating power of the gas being equally up to its standard; and wherever an installation of the electric light is introduced, the suppliers should be under most stringent regulations as to the voltage of the supply.

The means by which the energy, either gaseous or electrical, are to be utilized next invite consideration. These are: (1) Burners, which may be divided into two classes—viz., ordinary, such as flat-flames, Argands, etc., and recuperative, such as the Wenham, and others of that type first introduced by Herr F. Siemens. (2) Electric lamps, which may be also divided into two classes—viz., incandescent and arc lamps. For our purposes we may compare ordinary flatflame, etc., gas burners with incandescent lamps, and recuperative burners with arc lamps. Before making actual comparisons it will be well to consider the relative merits of each system, and fix the basis upon which it may be taken.

Good Argand burners will, with 16-candle gas, give from 16 to 17½ candles of light under the best conditions. But flat flame burners, at their best, will not give more than 15 candles of light; while a large number of inferior burners, used under the worst imaginable conditions, will not furnish more than 10 or 11 candles. We may therefore assume that, under normal conditions, in the majority of well regulated establishments, such as those wherein the electric light is most likely to be adopted, an all-round average of 14 candles per 5 cubic feet of gas per hour of 16-candle gas may be taken as fairly representing the truth. The average luminous energy per reputed 16 candle power incandescent electric lamp is about 13 candles; the watts being 59. Now, as the Board of Trade unit is 1,000 watts acting for one hour, we have an exact means for comparing cost. But, in order not to do anything to overstate the case, let it be assumed that the actual average light per 5 cubic feet of gas in ordinary burners is equal to only 13 instead of 14 candles. Then on this basis we have 59 watts giving 13 candles = 1,000 watts giving 220 candles per hour. On the other hand, if 5 cubic feet of gas burning during one hour yield 13 candles, 1,000 cubic feet will give 2,600 candles. If the price of the electric energy per Board of Trade unit is 6d., then the cost of 2,600 candles (= 1,000 cubic feet of gas) will be 5s. 11d. But here we are making an assumption of a startling character. We have taken the initial and not the working intensity of the incandescent lamp. Such a lamp, having an initial intensity of 14.8 candles, may, after 100 hour's work, fall to 14 candles; after 250 hours,

to 11.5 candles; and after 500 hours, to 10.5 candles, when it will remain practically constant. It may safely be assumed, therefore, that the above 13 candles of light for 59 watts will in a few weeks be reduced to 12 candles; and assuming it remained at that, the electric light at 6d. per Board of Trade unit would be equal to gas at 6s. 4d. per 1,000 cubic feet.

These figures are put forward so that anyone may be able to twist them about as he pleases, and thus obtain any results of which he may be in search. In like manner, if we desire to compare the cost of the best flat flame burners, giving the full 14 candles per 5 cubic feet, the electric light will cost 7s. 10d.; if with argand burners, giving 17 candles, 9s. 4d.; or if with Wenham or Sugg's "cromartie" burners, giving 7 candles per cubic foot of gas, or 35 candles for 5 cubic feet, it will be 17s. 2d. per 1,000 cubic feet of gas—that is, if the incandescent electric lamp can be depended upon to maintain as much as 12 candles with 59 watts, which, as shown above, is very problematical, both on the ground of actual intensity per unit of current and reduction in voltage of the current supplied, insuring a proportionate increase in the price charged. If the Board of Trade unit is 8d. instead of 6d., of course the above facts will be still more in favor of gas in that ratio.

In the case of arc lamps, the result is naturally different; but even here the unfortunate mistake of systematically overstating the actual intensity of the electric light has led to great confusion. As already shown, the effective intensity of a so-called 1,000 candle power arc lamp may be accepted at no more than 460 candles, or when reduced by the most suitable globes, let it be assumed at 300 candles at the best. This, with a consumption of energy equal to 500 watts, would equal 600 candles per Board of Trade unit; and at 6d. per unit this would indicate a price equal to 2s. 4d. per 1,000 cubic feet of gas, as compared with burners giving an average of 14 candles per 5 cubic feet of gas. But we must compare the arc light with the recuperative gas burner giving 35 candles per 5 cubic feet of gas, or 7,000 candles per 1,000 cubic feet; in which case the cost of the electric light would be equal to gas at 5s. 9d. per 1,000 cubic feet. It is evident, therefore, that what is wanted is a more economical and constant method of employing the arc light, so that the expense of renewing the carbons (not taken into account in the above estimate) and general attention could be abolished. Considerations of a similar character to the above applying equally, and with greater force, to the use of the albo-carbon and Welsbach system of using illuminating gas.

In thus stating the bare facts respecting the cost of the two illuminants, it must not be thought that all other considerations are overlooked; for, while it cannot be denied that the foregoing figures are borne out in practice—the replacement of gas by the electric light having, in a large number of cases which have come under personal observation, raised the lighting bill by some 2½ times—the advantages of having the atmosphere unvitiated by products of combustion, and the ready convenience of the new system, are elements not to be passed by. On this point there is a great deal to be said; and while the electricians have much of the argument on their side, the advocates of gas argue that the question of ventilation is one entirely in the hands of the consumer, and that, by the adoption of recuperative burners with ventilating tubes attached, the problem of comfortable, healthy, most efficient and economical illumination is effectually solved. Mr. W. H. Preece has said that the "electric light is essentially the poor man's light." Few people will agree with him as to its present position, whatever it may become in future. At the present time it is undoubtedly the light of luxury, except in certain businesses for which its peculiar properties specially adapt it.

Though efforts are being made to utilize the electric current for purposes of domestic heating, there can be little question that in this respect it must indeed be the heat of luxury for some time to come. Heating by gas is an accomplished fact, but heating by electricity is yet in its infancy; and even when it grows in years, it is a question as to how many would prefer to cook by a heat source which in cold weather would fail to warm the cook as well as the cooked.

In considering the merits of a scheme for introducing the electric light into small towns, the initial difficulty of inducing residents to incur the expense of wiring their houses must not be overlooked; and no project should be taken in hand until this point is fairly faced. When the electric light first began to find its way as a public illuminant, many persons expressed some fear lest the peculiar character of its rays might be injurious to the eyesight of those constantly at work by its aid. Careful inquiries on the point have elicited the fact that there is no evidence of injury from this cause. Another point was also debated with no little force—viz., the relative diffusive power of the rival illuminants. This, however, like many other objections, seems to have exhausted itself in the heat of debate; and the superior power of the arc light has enabled it to hold its own in competition with all others for outdoor illumination in this respect.

The most interesting feature of the electric light is the property of enabling a light to be readily obtained which is comparable to daylight in character, and therefore especially valuable when it is desired to differentiate colors. Whether or not the time will come when the intensity of the incandescent lamp can be readily varied under normal conditions of current, must be an open question; but undoubtedly it would be of immense advantage if it were possible to raise the temperature of the filament for temporary purposes, until it gave that quality of light which we know it is capable of doing under favorable circumstances—viz., affording a light sufficiently pure for distinguishing colors.

The character of the light obtained from the arc as well as the incandescent lamp has been made the subject of very extensive study, especially by Professor Nicholls, of the Physical Laboratory of the Cornell University, in America, who has published several papers upon the question, following the original work in this direction by Otto Schumann and others. In the course of these researches it was demonstrated that the efficiency, or ratio of the energy of the luminous radiation, of the arc lamp to that of the total radiation, luminous and non-luminous, in the horizontal plane, was found to be exceedingly small—varying from about 5 per cent. to a little less than 15 per cent., and the ratio increasing as the diameter of the carbons decreased. In the case of the incandescent lamp at the normal temperature of incandescence, where the intensity lies in the neighborhood of 16 candles, the efficiency does not rise above 5 or 6 per cent. Continuing, Professor Nicholls says: "Since the ratio of total radiation to light giving radiation increases but slowly as the temperature of the radiating body rises, the efficiency is not likely to be increased in any very marked degree until we shall have learned how to suppress altogether those long waves which yield us dark heat, and are able to limit the vibrations of our source of light to that brief octave which comprises the wave lengths to which alone the human retina responds. Whether this great step is to be made by robbing the glowworm and the firefly of their secret, as has been suggested by the Director of the Sibley College of Mechanical Engineering, or by other means, we know not." Mr. Thurston's remarks to the above effect were as follows: "The second of the greatest inventors is he who will teach us the source of the beautiful, soft, beaming light of the firefly and glowworm, and will show us how to produce this singular illuminant, and to apply it with success practically and commercially." Mr. Thurston claims that the dynamo electrical engineer has nearly solved this proolem. Doubtless he overlooked the fact that Davy and Faraday were chemists.

With regard to the degree of superiority which the electric light possesses over gas and oil flames in the important matter of heating effect on the surrounding atmosphere, Professor Nicholls states that the latter deliver to the room about 1,000 gramme calories of heat per minute for each candle power of 3.6 gramme calories of luminous radiation. An incandescent lamp of 5 per cent. net efficiency delivers only 72 gramme calories per candle power. Mr. Merritt, of the Cornell University, concludes, from experiments made by Dr. Thomson some 20 years ago, and since repeated by himself, that the true efficiency of an oil lamp as a light making machine is only about 0.3 per cent., or one-tenth of that of an incandescent lamp; and that the latter, though an immense improvement upon gas and oil lamps, is still far from being perfect in this respect. Doubtless, as he says, this is a question which merits the serious attention of investigators. In all these comparisons, carried out with so much care, the investigators have worked with the normal or ordinary gas flames. It yet remains to follow the work with the various improved forms of gas burners, such as those of the recuperative and incandescent type.

The by no means unimportant question of the relative spectra of the two illuminants under discussion has yet to be considered. Up to the present time, the work in this direction has been confined to the ordinary Argand burner, as already mentioned, so far as gas is concerned; and therefore the conclusions are by no means to be accepted as bearing upon the most recent improvements in gas consumption. However this may be, we may here consider them as they stand. Again we have to refer to the work of Dr. Julius Thomsen, Professor Nicholls and others. In the first place, it was found that the light of the candle and of oil and gas flames, although subject to considerable fluctuations from variations of the conditions under which combustion occurs, differ but slightly in quality from each other and from that of incandescent electric lamps maintained at normal candle power. The incandescent material in all is carbon, and it is a significant fact that the average temperature of incandescence is nearly the same in all luminous flames, and that the

highest temperature—at any rate until very recently—at which it has been found practicable to maintain the carbon filament of the glow lamp, is very nearly that at which the same material exists under most circumstances in oil and gas flames. Passing to other sources of illumination, such as the lime light and the electric arc, we find the entire portion of the spectrum lying beyond the yellow increasing more rapidly—regions of longer wave length than the yellow increasing less rapidly than the candle power, and the rate of increase growing steadily as the wave length diminishes from the red to the violet end of the spectrum.

Luminosity is the factor which we must take into account in seeking a complete expression for the efficiency of any source of illumination; and the method to be pursued in the determination of the luminosity must depend upon the use to which the light is to be applied. If we estimate light by its power of bringing out the colors of natural objects, the value which we place upon the blue and violet rays must be very different from that which would be ascribed to them if we consider merely its power of illumination as applied to black and white. In a picture gallery, for instance, or upon the stage, the value of an illuminant increases with the temperature of the incandescent material, out of all proportion to the candle power, whereas candle power affords an excellent measure of the light to be used in a reading room.

The luminosity of the blue and violet rays is so very small that, in the production of candle power, the influence of the very rapid growth of this end of the spectrum with increasing temperature of the lamp is scarcely appreciable. If we estimate the light giving value of the different portions of the spectrum by means of the facility with which we can distinguish black characters upon a white ground, the importance of the more refrangible rays is still further diminished. Thus Mace de Lepinay and Nicati have shown that, if yellow and blue light, estimated to be of equal brightness by photometric means, are of such intensity that one can clearly distinguish a printed page when illuminated by the yellow, the same page will be entirely illegible when the blue light alone falls upon it. These observers conclude, indeed, that "the mere distinguishing of objects is due almost exclusively to the illumination produced by the less refrangible half of the normal spectrum." So that at equal brilliancy "the superiority of yellow sources of light (luminous gas flames, incandescent lamps, etc.) over sources richer in blue rays (such as the light of the electric arc) is incontestable." "The only real advantage," they add, "upon the side of the light from the electric arc is when one desires to rehabilitate objects more nearly in the hues which they present in the light of day." This single advantage is one which it is impossible to take due account of numerically in an estimate of the efficiency of artificial illuminaiion. It is nevertheless a most important factor in determining the adaptability of a light to nearly all the purposes of everyday life.

In the course of a discussion before the American Institute of Electrical Engineers, Professor Nicholls pointed out that if we have three incandescent lamps of different sizes, but each subjected to such a current as is required to give 16 candles by the photometer—the larger lamp having the smallest current, and the smallest lamp the greatest current—they would vary in total luminous energy and in total light giving value as measured by their luminosity. The smaller lamp with the strongest current would be very much weaker in the red rays, and the blue would be correspondingly much stronger. If we know the state of incandescence and the temperature of the radiating surface, we have a complete definition of the performance of a lamp, and we can then express exactly what it will do for any purpose for which it is designed. If we want colors, we use it at a high incandescence. If we want the greatest possible reading power, we shall get a maximum for that purpose at a lower temperature.

"Unknown" Causes of Fires.

Mr. H. C. Cushing, Jr., well known in Eastern insurance circles, says: Any fire which takes place in any city of considerable size is recorded as to location, loss, amount of insurance carried, and the cause, or supposed cause of the fire. In the city of Boston there were, during the year 1893, 1,233 fires, with a loss of $5,024,765.04. Twenty per cent. of all these fires are from unknown causes. When these unknown causes cost property owners more than $1,004,955, it is about time that some investigations were made beyond attributing these causes to spontaneous combustion, incandescent or arc light wires, or to any other wires which enter a building. When an inspector cannot satisfy himself that it was from stoves, careless use of kerosene or matches, it is a very easy thing to lay it to spontaneous combustion or the unfortunate electric light wires.

The person attributing fires to the electric light wires being crossed with some trolley or other high potential wire outside is probably not aware that every wire entering a building is thoroughly protected at its entrance by a fusible metal which will blow out at any over-charge, thus deadening every wire in the building; and, moreover, there would have to be a decided ground within the building, which is nowadays a very rare occurrence, as the writer's investigations have proved that out of 25 prominent buildings in the city of Boston the insulation resistance to ground proved to average over 2,000,000 ohms. But when I say that the electric light and power wiring should not receive the blame as often as it does, I do not mean to take the responsibility off of electricity, for it is through this agent that I have reason to suspect the origin of many of the "unknown" causes, so called, in fire reports.

When electricity is allowed to roam at large and in vast quantities all along our water and gas pipes and through the ground upon which the city is built, in order to get back to the sources from which it was generated, which are the street railway power stations, it is this state of affairs which is creating a trouble, the extent and seriousness of which is only known to those few who have made it a study. These street railway power stations, operating the overhead trolley system, are constantly generating thousands of horse power of electricity, sending it out by overhead trolley and feed wires to the cars which it operates, and returns it to the station by means of the water and gas pipes which lie in its course. For this reason there is a tremendous electrolytic action going on all the time. When I speak of this trouble from electrolysis I do not mean that Boston and Cambridge are the only cities affected, but every city in the United States operating a trolley system with ground returns. The writer has samples of gas and water pipe completely eaten through by electrolytic action in three months after having been placed in the ground near street railway returns. This effect has been going on and will continue to go on as long as there is a grounded wire in electric street railway construction.

Wherever this returning current flows in any quantity along a pipe there is bound to be a large fall of potential, varying in different pipes as their carrying capacity increases or diminishes.

In the cellars and basements of many houses I have found quite a large difference of electrical pressure between two pipes entering within one foot of each other, and in one instance it was a very easy matter to take a piece of hoop iron and draw an electric arc sufficient to ignite a piece of waste held near it, and by connecting these pipes together with a piece of No. 18 copper wire, the current flowing through it was sufficient to heat it so that it was impossible to lay one's hand upon it. In the basement of another building, not 200 yards from where the writer sits, I find a man using 25 amperes at 8 volts pressure, or electricity enough to run small motors and incandescent lamps, as well as the electrical bells in the entire building, by simply twisting his wires around two different water pipes which enter the building.

Some time ago my attention was called to two pipes which were so close together that the vibration of an elevator engine caused them to knock together just sufficient to create an arc every time a contact was made and broken. This had been going on so that it had almost completely eaten through the gas pipe, and it is perfectly evident what would have taken place had this been allowed to go on unobserved. The gas would have been ignited, as soon as the first small hole appeared, by the electric spark, and disastrous results would have undoubtedly followed.

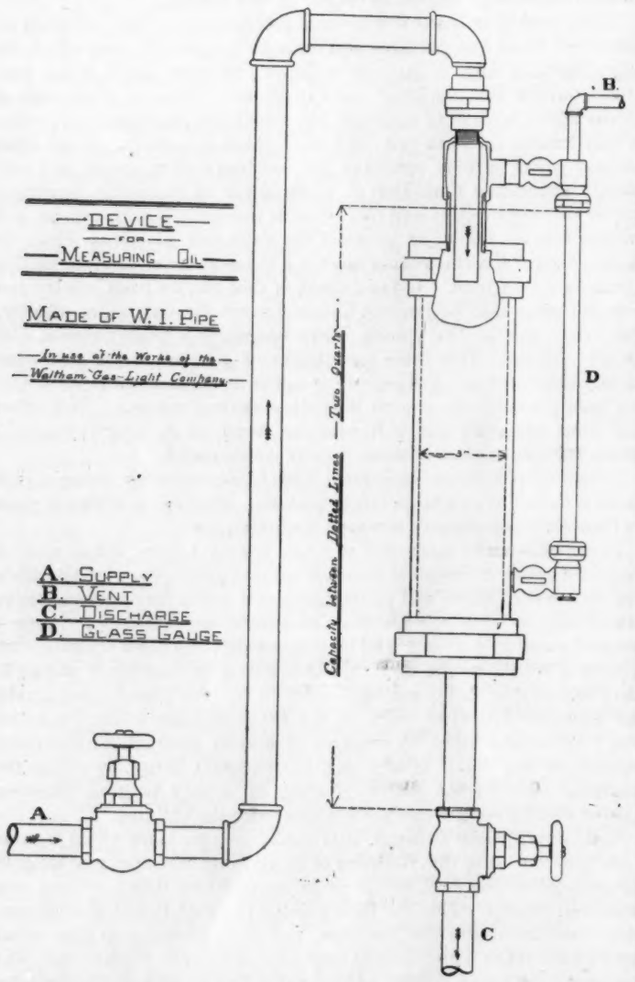
This difference of electrical pressure upon water and gas pipes is now so well known that in a number of cases in the cities of Boston and Cambridge the ordinary electric bell battery is entirely discarded, and the wires from the bells connected directly to the water pipes, the latter furnishing an inexhaustible supply of electricity at the proper pressure to run any number of bells or gas lighting apparatus, and also to do any quantity of mischief. I can see no reason why fires should not be attributed to this cause, when it can be proved that such a difference of electrical pressure really does exist between any two pipes entering a building in the vicinity of the trolley system of street railways.

There is only one way of eliminating this rapidly increasing danger, and that is by compelling the electric street railway companies to insulate, from the ground, their entire electrical circuit, and just as soon as a suit for damages is brought by the water and gas companies for a complete system of pipes destroyed by electrolysis, the railway companies will begin to remedy the evil, which they are more fully aware of than anyone else.

THE Wells-Fargo Company have filed an action, in the Third District Court of Utah, against the Ogden Gas Light and Fuel Company, under which they seek to recover $14,750 on a promissory note.

Kelly's Device for Measuring Oil.

The device for measuring oil, a very complete illustration of which is given herewith, was perfected by Mr. Henry H. Kelly, Assistant Superintendent of the Waltham (Mass.) Gas Light Company, in which works it has given perfect satisfaction for some time. The illustration carries out its principle so clearly that verbal explanation is really unnecessary, but we may say that the apparatus, which can be devoted to measuring other liquids than oil, is made entirely of wrought iron pipe, the supply and discharge pipes being ¾ inch in diameter, the chamber with glass gauge attached being 3 inches. All of the joints are put together with shellac instead of lead, and are perfectly tight.



In using, close the valve at *C*, and open slowly the valve at *A*, all the time observing the gauge glass. With a pressure of 15 pounds or more it fills rapidly. The tee above the chamber is of the reducing type, 1 inch by ½ inch by ¾ inch. The supply is reduced to ½ inch, a nipple of that size being carried in the interior of the tee, and through its upper part from inside, the union being made upon that. The nipple must be long enough to pass through the tee and the 1-inch nipple below it, and extend about ¼ inch under the inside top of chamber, to provide proper vent in filling, which vent is between the 1-inch and the ½ inch nipple, and through outlet of tee (¾ inch) to top of glass gauge, the same being open, as shown at *A*.

SPECIAL ENGLISH CORRESPONDENCE.

COMMUNICATED BY NORTON H. HUMPHRYS.

SALISBURY, April 10, 1894.

Coal Contracts.—The Residual Markets.—Gas Engines and Electric Light.—Incandescent Gas Burners.—Distribution of Electricity.

The question of contracts for the supply of coal for the ensuing 12 months is now before the minds of most gas managers and members of managing committees, and the matter is regarded in several ways and from new points of view, in the light of experiences brought about by the events during the latter part of the past year. The special point to which scrutiny has been directed, it need scarcely be added, is the "strike" clause. Up to the autumn of 1893, a contract was looked upon as a kind of guarantee for the supply of coal. Tenders were considered in the spring of each year, an approved price was accepted, and the general feeling was that the concern was as "safe as the bank" in the matter of delivery of coal. As in all other classes of business, it was felt that the word of a reputable firm was as good as its bond, and when several firms of this class decided to take advantage of the strike clause, on the very day that the stoppage of work was declared at the pits, and announced to their customers that they intended to suspend deliveries under contract until work was resumed—a period, as it turned out, of no less than 16 weeks—this feeling of confidence received a rude shock. Rightly or wrongly, gas companies had generally believed that such a decisive step would not be taken so long as a stock of coal remained at the pit head, and looked at the fact that considerable reserves were kept on the bank as a kind of guarantee to themselves. They depended, in fact, upon that feeling of confidence which is the essence of all business, and did not believe that their friends would repudiate their engagements until the last pinch. It is only just to add that many sellers made strong efforts to help their customers, and incurred not only trouble but actual loss in endeavoring to do so, but the exceptions to this course were so numerous that a very deep seated feeling on the matter of coal contracts has been created. Perhaps it would be going too far to say that some of those who knew that the strike would come, laid themselves out to work it to the best advantage, but it is a fact that some who repudiated contracts had, if anything, larger stocks than usual. In several instances, gas companies were forced to compete in the open market, under famine prices, for the very same coal that they had contracted for.

After such bitter experiences, purchasers are weighing the pros and cons of contracts, and they will never be inclined, in the future, to attach such a value to the item of security of supply, as they have in the past. In other words, they will require greater inducements before accepting long contracts. In several instances damages for failure to supply have been suggested, and the liability to such has been admitted more than once, but too much must not be made of this point, as it may have been due to special wording or special clauses in the contract, that the contractor submitted to an adverse decision. I am not aware that the general question, whether the purchaser can force delivery so long as the stock of the contractor holds out, has ever been fought out. The Edinburgh and Leith Gas Commissioners have been considering their position in respect to strike clauses, and have decided that in the event of a provision of this nature being included in any future contract, a clause shall also be included to provide that, in the event of a strike or lockout occurring during the period embraced within such contract, the contractor shall be bound to supply coal to the Commissioners, in preference to outside customers, so long as a stock of coal exists at the pit. And further, that each contractor or owner of the coal supplied shall be bound to keep in stock a quantity of coal equal to 20 per cent. of the total quantity contracted for. It will be interesting to know if the Commissioners are able to get these terms adopted in any contract of magnitude without having to pay indirectly for the same on the cost of the coal. The adoption of such a clause to anything like a general extent would mean a large increase in the stocks at the pit head. This would be objected to by the miners, whose policy has been directed towards the reduction of stocks. Their idea seems to be that a shaky coal market is the best thing for their interests. That they have simply to create a panic and then make their own terms. But they overlook the fact that, after having once suffered from the effects of such a policy, purchasers look round for a means of resisting it. If powerless in other ways, they can at least do a great deal in the way of studying economy, and reduce their consumption in various ways. It is surprising how much can be endured in the direction of "doing without" when once people have a mind to try. At present the coal market is in a very slow way, owing to the bright and warm weather that has prevailed all through the spring, and coals generally will have to come down in price. But the feeling that gas and railway companies can be forced to pay higher terms is still in evidence, and strong efforts will be made in the direction of forcing the prices of gas and steam coals.

The market for residuals is in a favorable condition. Tar is a little better, but not much. Sulphate of ammonia has made a good jump, and is selling well at £13 to £14 per ton—an advance of something like £3 on last year's average. The events above mentioned have been a valuable advertisement of the capabilities of coke for household purposes, and the result is that the coke yards are nearly empty and the prices are consequently well maintained. Under ordinary circumstances the mild winter and fine spring that we have experienced would

have led to the accumulation of large stocks, and the country would have been inundated with coke at take it away prices. As the rate of production of all classes of residuals is now declining toward the usual summer mimimum, there is every reason for hoping that a good season will be experienced, and that an important proportion of the losses during the second half of 1893 will be recovered during 1894.

A recent number of the *Gas World* contains an interesting report on the use of gas engines in Glasgow as a means of providing the necessary motive power for generating electricity, forwarded by a correspondent in that city. It is now some years since Mr. John West, the President of the Gas Institute for the current year, drew attention to the fact that for the lighting of large establishments by electricity the cheaper way was to generate the force on the premises. And that with gas at usual rates a gas engine and a dynamo would provide the current at some thing like half the price at which it could be purchased from a supply company. The reason for this is no doubt due to the saving of loss by leakage, which is evidently very large. For the electricity which perforates gas and water pipes, causes explosions, kills horses, and performs other vagaries, costs just as much to produce as that which goes to the premises of the customer, and is used to evolve light, in an orderly and orthodox manner. The report above instanced quotes several examples of the saving effected by following this plan as compared with electricity purchased from the corporation at the price of 7d. per Board of Trade unit. One firm, owning several different shops, claim to have reduced their electricity bill one-half. At another firm, the cost for gas only, ranges from less than 1d. at full load, to 1½d. at half load, per unit of electricity produced. After referring to other instances, the author concludes with the assertion that the average cost of the electricity produced by these gas engines is about 3d. per Board of Trade unit, as compared with 7d. in Glasgow and 8d. at some other supply stations throughout the kingdom.

A notable feature during the past lighting season has been the increased use of incandescent gas burners. They were introduced in all our principal towns early in the autumn and have remained in use. This principle of gas burner is no stranger to us. It has been before the public in various forms, but previously has not been adopted to a sufficient extent to make it worthy of classification as one of the appliances by means of which gas is consumed. The hindrances to its adoption have been of a practical nature. It has generally been admitted that the principle is sound, and that, given an efficient appliance, a larger duty can be developed per cubic foot of gas used than from any other form of gas burner, the regenerative included. This economy of gas carries with it other advantages, such as a corresponding reduction in the amount of heat evolved, and in the vitiation of the air.

The greater part of the difficulties encountered in the supply of electricity from central stations, appears to rest with the distributing system. More accidents have occurred in the streets than in the generator houses on the one side or the residences of users on the other. Not only is the distributing plant uncertain in its action, but very costly. At a recent meeting of the Northern Society of Electrical Engineers, two papers were submitted on the subject of underground electricity mains. We have frequently discussed the dangers to which gas and water pipes are exposed by the proximity of electrical conduits, and it is interesting to look on the other side of the shield and see what the electricity folks have to say about gas and water. The various systems considered were armored cables, insulated cables, and bare copper lines laid in culverts. Mr. Clirehugh, who read the first paper, considered that the latter was the best system. The qualities to be sought for were cheapness, durability, facility for inspection, repairing, jointing and increasing the area of the line without disturbing the ground, and the culverts combined a greater share of these advantages than the other systems named. The chief objection to it was the space required, which could not always be obtained, and in large cities the armored cable was often used on this account. The bursting of a water main might flood a conduit, and so stop the supply, and accumulations of gas might occur and result in explosion. So he preferred that the conduits should be water-tight, and argued that gas would be less likely to accumulate in water tight culverts than in systems of iron pipe, which were put together without any attempt at tightness. The question of whether bare conductors were more likely to ignite an explosive mixture than covered ones had been much debated, but the author was of opinion that more explosions are caused by lighted matches or candles than by sparks from the conductors. He spoke of oak, concrete, and copper, as being good, durable materials for the construction of culverts and mains. The author of the second paper, Mr. Rider, did not see how the occasional presence of explosive gaseous mixtures could be prevented, and therefore recommended thorough ventilation of all electric pipes, conduits, manholes, etc., together with care in the first place, and periodical inspection afterwards. The fact that the armored cable was free from any cavities where gas or water could accumulate was a great point in its favor. A good subway system would be a great advantage in respect to distribution of electricity, but would be impracticable for other reasons. It is remarkable that neither of the readers appear to make a special point of soundness. The essential feature of any system of distribution is the avoidance of loss or leakage, which not only means a continual direct loss, but may lead to actions for damages. It is amusing to see that gas and water pipes and electricity conduits are mutually distrustful. Gas and water engineers suspect the conduits of a tendency to leak out currents that corrode or perforate the pipes, while the electrical gentlemen, in their turn, think that water pipes may burst, and gas pipes may leak, to the detriment of the "current" in either case.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE Grand Rapids (Mich.) Gas Company has declared its usual quarterly dividend of 2½ per cent., and is busy laying 500 tons of mains in hitherto unoccupied territory. The low price for gas in Grand Rapids (80 cents to $1 per 1,000 cubic feet) has so stimulated the use of stoves that the Company buys them in carload lots.

THE Trustees of the village of Geneseo, N.Y., have awarded the contract for the public lighting to the Geneseo Gas Company, which will at once put in an electric plant of the Wood type. The Company agrees to maintain 1,200 candle power arcs, on a moonlight schedule, for $65 each per year, and to maintain 16-candle power incandescent electric lamps for 70 cents each per month.

ON April 19th the Carlisle (Pa.) Gas and Water Company applied for an injunction to prevent the Cumberland Valley Traction Company from laying tracks in Carlisle. The basis of the plea is that the return currents in the rails will cause electrolysis of the water pipes. The case, which will come up for argument on next Wednesday, is said to be the first of the kind on record.

THREE ordinances were brought into the Select Council, of Philadelphia, by Mr. W. Findlay Brown, all of which were referred to the Gas Committee. The first ordinance authorized a loan of $2,500,000 by the city for the erection of two plants for the manufacture of gas, in the following terms. The Mayor to be empowered to "borrow from the highest bidder or bidders, at not less than par, the sum of $2,500,000, bearing 4 per cent. interest per annum, for the purpose of erecting two water gas plants, one to be erected at Point Breeze works, and one at the 25th Ward works, of the daily capacity of 12,000,000 cubic feet of gas each. Whenever any loan shall be created by virtue of this ordinance there shall be thereafter annually appropriated out of the revenue of the city and from the money raised by taxation a sum sufficient to pay the interest on said loans, and after the loans shall become payable there shall be annually appropriated for the payment of the principal the sum of $300,000, until the whole principal shall have been paid." The second ordinance, bearing the title "to increase the city's gas producing capacity," is as follows: "Section 1. The Select and Common Councils of the city of Philadelphia do ordain: That immediately upon the passage of this ordinance the Mayor is authorized to advertise for one month, in such manner as he may deem best to give publicity to the same, for proposals for the erection of two water gas plants, upon ground to be furnished by the city, one at Point Breeze and one at the 25th Ward works, each capable of producing and delivering to holders 12,000,000 cubic feet of gas per day. Sec. 2. All proposals shall contain the following items duly guaranteed and clearly stated in order, and any others that may commend the proposition of each bidder: (1) Candle power of gas to be furnished. (2) Maximum per cent. of carbonic oxide found in gas manufactured by his process. (3) Guaranteed cost of gas in holder, and on what cost of coal and oil the same is based, provided the same shall not exceed 25 cents per 1,000 feet. (4) Maximum heat units of gas to be produced. (5) Maximum cost at which plant to produce 12,000,000 cubic feet of gas of guaranteed candle power and purity per 24 hours will be erected for this city. (6) Terms upon which the city will be permitted to use the patents, and length of trial before payment will be required, and terms of trial. (7) Amount of bond that will be furnished to guarantee fulfilment of contract. (8) Full specifications of proposed buildings, ground required for their erection, time within which work will be completed and plans ready for operation. Sec. 3. Each bid shall be accompanied by bond in the sum of $10,000, with sufficient surety as guarantee, to be forfeited in case party so bidding shall fail to enter into

contract if bid is accepted." The third ordinance, which proposes to repeal the existing contract for the supply of water gas to the city, is: "Section 1. The Select and Common Councils of the city of Philadelphia do ordain that an ordinance, entitled an ordinance to authorize the Mayor to enter into contract or contracts for an increased supply of gas, approved April 6, 1888, be and the same is hereby repealed. Sec. 2. The Mayor is hereby authorized to give notice to the respective parties, immediately upon the passage of the ordinance required by any contract existing under the ordinance hereby repealed, that said contract will not be renewed at its expiration."

AT the annual meeting of the Savannah (Ga.) Gas Light Company the following officers were chosen: Directors, J. M. Clinch, Jacob Raners, H. H. Gilmer, William M. Law, Robert MacIntyre, A. R. Lawton and John Nicholson, Jr.; President and Treasurer, A. G. Guerard; Vice-President, John C. Rowland.

THE Flatbush (L. I.) Gas Company is installing an electric lighting plant.

THE annual meeting of the proprietors of the Ottawa (Can.) Gas Company was held pursuant to notice, the President (Mr. John Coates, C.E.) directing the proceedings. From the annual reports it was seen that the Company had prospered during the year, notwithstanding the competition of the local electric lighting concern. During the year a water gas plant was installed, and the Company is now supplying a 23 candle power gas to its customers. The demand for cooking stoves and ranges was very pronounced, and the Company's send out on account of other than lighting uses amounts probably to 15 per cent. of the total make. The election resulted as follows: Directors, J. Coates, R. Blackburn, T. R. Clemow, Alex. Ferguson and A. B. Phillips; President, J. Coates; Vice-President, R. Blackburn.

MR. T. S. MCLACHLIN, President of the Whitehall (N. Y.) Electric Light Company, has purchased a controlling interest in the Whitehall Gas Company, having secured the stock which stood in the name of the late Frederick A. Sabbaton, and both concerns will hereafter be operated in harmony. The electric machinery will be removed in short time to building to be erected on gas works site, and a new incandescent light machine will be set up.

MR. WILLIAM H. MORGANS, Superintendent of the L. R. Medbury Gas Works, of Pontiac, Mich., forwards us a copy of the following announcement recently made in the columns of the local newspapers: "On and after May 1st, until further notice, the price of gas will be reduced 25 cents per 1,000 cubic feet from the present prices. Gas for illuminating purposes will be $2 per 1,000, with a discount of 50 cents per 1,000 if paid at the office on or before the 10th day of the month following its use, making illuminating gas, net, $1.50 per 1,000. Gas for fuel purposes will be $1.75 per 1,000 cubic feet, with a discount of 50 cents per 1,000, the discount to be governed by the same rules as the illuminating gas, making the price, net, $1.25. The Company is very desirous of pushing the gas stove trade, and to that end has purchased a building, 11 South Saginaw street, where it will have a full line of gas stoves, both for cooking and heating purposes, and would be pleased to have the public call and examine the same. The Company will occupy its office at 11 South Saginaw street after May 1st. The prices at which gas is now sold are fully 30 per cent. lower than for cities of similar population, yet it will be our policy to further reduce the prices as soon as an increased consumption will justify it."

THE advertisement also carries the names of 63 housekeepers who use gas for cooking purposes.

THE New Bedford Gas and Edison Electric Light Company has declared its quarterly dividend of 1½ per cent.

AT the annual meeting of the stockholders of the Bridgeport (Conn.) Gas Light Company the Directors chosen were: William R. Higby, Samuel C. Trubee, H. L. Clarke, W. B. Hincks, W. D. Bishop, W. H. Perry, E. G. Burnham, A. J. Hobbs and Morris B. Beardsley. The Directors subsequently perfected the following organization: President, W. R. Higby; Secretary and Treasurer, F. B. Sammis; Superintendent, Charles A. Gerdenier.

A DESPATCH from Washington, D. C., dated April 21st, is to the effect that a bill to incorporate the National Gas and Electric Light and Heat Company, for Washington, has been offered in the House of Representatives by Mr. Timothy Campbell, of New York. The incorporators and initial Board of Directors are: Messrs. J. Wesley Bovee, George W. Harvey, John F. Chamberlain, Davies Murdoch, S. Sterrett McKim, Chas. C. Lancaster, George B. Cowlain and Wm. F. Mason McCarty. The Company is authorized to manufacture gas from coal, oil, naphtha, tar, peat, pitch, or turpentine or other material, to be used for lighting or heating in the District of Columbia. The illuminating power of the gas shall not be less than 24 candles, and it shall charge not to exceed 60 cents per 1,000 cubic feet for lighting the streets and public buildings, and not more than 75 cents per 1,000 cubic feet to private consumers.

THE Committee on Manufactures of the Massachusetts Legislature reported leave to withdraw the petition of the Mayor of Newton for authority to engage in the manufacture and distribution of gas and electricity on municipal account.

AT the annual meeting of the stockholders of the Derby Gas Company, of Birmingham, Conn., the following Directors were elected: William B. Wooster, William E. Downes, Royal M. Bassett, Thomas Wallace, Frank E. Hoadley, Charles E. Clark, William H. Matthews, H. Holton Wood and Chas. H. Nettleton. At a subsequent meeting of the Directors the following executive officers were chosen: President, W. B. Wooster; Clerk, Treasurer and Agent, Charles H. Nettleton.

THE Newark (N. J.) *Advertiser*, of the 16th inst., had the following to say, which is given for what it may be worth, coupled with the remark that we have no advices of our own bearing upon the subject: "The Newark Gas Light Company and the Citizens Gas Light Company are to be consolidated, the latter, which is the smaller, absorbing the former, and a new Company, which will be known as the Newark Gas Company, is to be incorporated with a capital of $1,000,000 Bonds to the amount of $4,000,000, secured by a mortgage covering the plant of the new Company, will be issued. These bonds will draw interest at the rate of 6 per cent. The stock of the Newark Gas Light Company amounts to $1,500,000. In payment for this the stockholders will receive $2,500,000 of the $4,000,000 mortgage bonds, and in the final settlement they will also be permitted to divide among themselves the cash on hand, which is estimated at 50 per cent. of the present stock. The capital stock of the Citizens Gas Light Company is $1,000,000. In exchange for their present holdings the stockholders in this Company will receive share for share of the stock of the new Company and the remaining $1,500,000 of the mortgage bonds. In addition they will divide all the cash left in the treasury of the Citizens Company after the payment of the expenses of the consolidation. The present stock of this Company is of a par value of $50 per share and a market value of $100. Henry C. Kelsey, the Secretary of State, who is in the Directorate of the Citizens Gas Light Company, arranged the consolidation."

WHILE there is undoubtedly some truth in the statement that something of the kind above noted is underway, we incline to the view that the details are far from being accurate or authentic, notably in respect of the amount of capital stock to be issued by the succeeding Company.

THE daily papers of recent date state that a suit has been brought by Messrs. T. J. Preston & Co., linseed oil manufacturers, of Newark, N. J., against the Newark Electric Light and Power Company, in which plaintiffs claim $100,000 damages occasioned their works by vibrations caused by the engines and machinery of the Electric Light Company. T. J. Preston & Co. erected brick buildings on foundations in "made land" on the Passaic river front, in 1886, and five years later the Electric Light Company built alongside. The latter's engines and machinery, it is claimed, shake the neighborhood for 1,000 feet around. Preston & Co. claim their buildings are now 6 inches out of plumb, and that the vibrations have seriously affected the business in which they are engaged, in that the shaking of the premises so disturbs the contents of the tanks that fine oil is an impossibility, and since 1891 the product is only salable at a price below the market rate. The defence is that the vibration is exaggerated, and that the alleged crevices in the walls either do not exist or are trivial; further, that the Preston Company recently had a severe fire in their premises, in the course of which, and as a result of, the walls of their buildings were more or less damaged.

THE Buffalo (N.Y.) Trust Company is complainant in an action against the Medina (N.Y.) Gas and Electric Light Company to recover $14,541.50 due on bonds and interest. The bonds were issued by the old Medina Gas Light Company and the succeeding Company refuses to recognize their validity. The claim is also made that a $75,000 mortgage is ahead of these bonds. The case is on before a referee sitting in Rochester.

THE papers in a suit, in which the Capital Gas Company, Sacramento, Cal., seeks to recover $122.70 from the city, have been filed in the Superior Court, by A. L. Hart, attorney for the Company. The sum sued for represents claims for public offices, etc., for which the Auditor has refused to draw warrants, on the ground that the Mayor, Mr. B. U. Steinman, is an interested party, in that he is also President of the Gas Company.

THE San Franciso Gas Light Company has declared its April dividend of 35 cents per share, or $35,000. The Oakland (Cal.) Company has also declared a dividend of 20 cents per share for April, amounting to $6,000.

THE new electric light and power station for the Brush Electric Light Company, at Baltimore, Md., will be one of the finest in the Southern States. The boiler room is 83 feet wide by 129 feet long and the dynamo room is 130 feet square, the floor space in the latter being entirely free from posts. The roofs are designed and built by the Berlin Iron Bridge Company, of East Berlin, Conn., and are made entirely of iron, covered by the Bridge Company's patent anti-condensation iron roof covering.

DR. HOWARD JONES, President of the Circleville (Ohio) Light and Power Company, forwards the following, under date of April 23d:

To the Editor of the AMERICAN GAS LIGHT JOURNAL: It seems plain to me that the interests of the gas business cannot be advanced by statements calculated to mislead. When gas engineers discuss electric lighting, unfortunately for their own interests, there are too often sophisms which may console for the time, but which in the long run must damage the owners of gas shares. Mr. Patterson, Inspector of Gas and Gas Meters for Allegheny county, Pa., is made to say, in your JOURNAL for April 16, 1894, in his report for 1893, "Digressing, perhaps, from matters to which this report should be limited, I may be permitted to say a few words touching the relative efficiency and economy of electric light and gas illumination in domestic lighting. The basis of contracts for this character of lighting in Pittsburg is an incandescent lamp, for which the Company charges about 1 cent per hour, and its greatest efficiency under a certain and constant pressure will yield a light equal to 16 candles. I do not know of any electric lighting system for which the term of a lamp's service is claimed to be more than 600 hours, and I think all will agree that its greatest brilliancy is when first set, and from that time its illuminating power is depreciating, until finally it has to be replaced by a new lamp. If it lasts 600 hours, the average of its illuminating value would be about 8 candle power, but usually long before that time, if the lamp does not burn out, it changes from an incandescent to a dull red, and the consumer finds it necessary to renew it in order to obtain a good light, and this is an additional expense to the meter rate. Now let us see how the gas compares with electric illumination, both in light and cost. The Gas Companies of Pittsburgh and Allegheny are furnishing a gas that is uniform and never less than 20 candle power; that is, 5 feet of gas burned under fair conditions, and with suitable burner, will give a steady and continuous light equal to 20 candles, and this will cost exactly one-half a cent, while an electric light, for which at its highest efficiency only 16 candle power is claimed, costs 1 cent per hour. We thus find that the electric light costs 100 per cent. more than the gas, and at its best gives 20 per cent. less light, and, when it is considered that the illuminating power of gas is not variable, while the electric light is affected by the slightest change in pressure, we may safely say that the gas does not cost more than one-fourth as much as electric light." There are numerous lamp manufacturers who will guarantee their lamps to maintain their candle power to within 1 to 5 per cent. during their entire life, and will guarantee that life to be over 600 hours. Instead of the value of an incandescent lamp being 8 candle power it is practically 16 candle power. I have seen lamps, and am now using some that have been in use over 3,000 hours, that are not yet "dull red." If a 16 candle power lamp is supplied with current at the rate of 1 cent an hour, and the lamp takes 60 watts per hour, then 6,000 watts will maintain a lamp 100 hours; that is, the current sells at $1.66 per 10,000 watts. If the rate for gas in Allegheny is $1 per 1,000, and 5 cubic feet of said gas, burned in a lava tip burner gives 20 candle power of light (Mr. Patterson's estimate), then 4 cubic feet equal one 16 candle power lamp. An amount of gas light to equal $1's worth of incandescent electric light costs 40 cents. If the gas is used in a regenerative or incandescent burner the showing will be better for gas. Then, light for light, glow electric light costs 60 cents more than gas light for every 100 hours of use, allowing about 4 watts of current for every candle power, and for each cubic foot of gas 4 candle power. In properly managed stations the change of voltage should not be sufficient to perceptibly alter the candle power, and practically it does not. Now, your Boston correspondent of same date figures upon cost of output of electric light and gas light, taking for his premise the very poorest efficiency of electric stations. I know a station that every day of the year gets 1 indicated horse power for every 4.2 pounds of coal burned under the boilers. The coal costs at the furnace doors about 90 cents per ton. What does this mean? As there are 746 watts per horse power, and each incandescent lamp of 16-candle power takes 60 watts, it means 1 pound of coal will maintain three such lamps one hour, or will produce 48 candle power of light, costing, for coal, .045 of a cent. Now, what are we doing in the gas business that will bear comparison with this? I know a gas plant, not miles away from the electrical station referred to above, that can make every day of the year an average of 4 cubic feet of gas per pound of coal that costs $1.80 per ton. The residuals sell for two-thirds the price of the coal, so its actual cost is but 60 cents per ton. Six cubic feet of this gas, burned in a lava tip burner, give a light equal to the best so-called 16-candle power incandescent electric lamp; that is, 48 candles of light cost .135 of a cent, or three times as much as the same quantity of light from an electric glow lamp. Of course this does not represent the average of stations, either for electric light or for gas; it only shows what can be done with equally efficient plants, the question of wear and tear not being considered. Gas men should know what an efficient electric incandescent plant can do, and electric light men should know what an efficient gas plant can do. In small places the lighting business should be under one management. What we want, as practical and scientific gas men, is the best each can do. We shall not be benefitted by statements of the best showing for gas and poorest for electricity, or *vice versa*.

THE Street Light Committee of the San Francisco Board of Supervisors recently awarded the contracts for lighting the public buildings of the city, except the City Hall, for the ensuing year. The Pacific Gas Improvement Company and the Edison Light and Power Company secured the contracts, gas to be furnished at $1.75 per 1,000 cubic feet and electric lights at 13 cents per 1,000 watt hours. The City Hall will be lighted by the same Companies and at the same rates, but the contract will only be from month to month until it is decided whether the Commission will put an electric plant in the building.

THE electric light plant of the Sacramento (Cal.) Gas Company, perhaps the finest of its type on the Pacific Coast, was destroyed by fire on the morning of the 18th inst. Much confusion resulted from the disaster, as the Company, besides furnishing currents for the arc and incandescent lighting of the city, also furnished motor power for the street railway system. The loss exceeded $200,000.

THE Peoples gas works, at Little Falls, Minn., which have been idle for a year, were recently sold to S. P. Casey, at his bid of $575, subject to an indebtedness of $5,000.

MESSRS. J. F. ROGERS & CO., of New York city, have placed the order for a new industrial school building, at Havana, Cuba, with the Berlin Iron Bridge Company, of East Berlin, Conn. The building, which is to be 15 meters wide and 48 meters long, is to be constructed entirely of iron and cement.

NEGOTIATIONS for the construction of a gas plant, on what is known as "the Island," virtually a suburb of Toronto, by the Consumers Gas Company, of Toronto, are off for the present, mainly because Mr. Pearson has discovered that under the city by-law preventing the renewal of "the Island" leases, he may be at the mercy of the authorities without means of redress. In case the by-law forbidding the renewal of leases is repealed—which seems to be more than a probability—the works will be constructed.

THE Verein zur Beforderung des Gewerbefleisses, of Berlin, is offering a silver medal and a money prize of $750 for the best paper giving chemical and physical analyses of the iron paints mostly employed. Very little definite information is known regarding the application, duration, effect, etc., of these paints, and the papers above invited should contain (1) a description and classification of the paints frequently used, based on a chemical analysis; (2) a statement of the materials and mixtures which form the most suitable paints for application to all kinds of iron. All papers in the competition are to be forwarded by November 15, 1894.

THE F. C. De Prenyal Gas Range Manufacturing Company, of Washington, D. C., will put up a factory in the settlement known as Warsaw. A show and salesrooms will be located in Baltimore.

THE stockholders of the Louisville (Ky.) Gas Light Company have agreed to an increase in the capital of $600,000, and have also signified their willingness to hereafter accept a decrease in the annual dividend of 1 per cent. The increased stock is to be sold for the purpose of paying for the electric lighting plant, which up to date has cost the Company almost $1,000,000.

The Market for Gas Securities.

Our advices of some weeks ago seem to have been quite prophetic, for to-day (Friday) is to witness the adjournment of the Legislature and no gas bills have been reported, which means that $1.25 is to be the city rate for a twelvemonth. Consolidated was notably strong during the week, and some good days' trading in it were reported on the Exchange. The opening to-day was made at 138⅝ to 138¾, and while the market for it looks strong, we nevertheless believe that it is pretty near its maximum. Other city shares are firmly held, notably Equitable, which is likely to go on again to the 200 notch. East River bonds are offered occasionally, but there does not seem to be any overwhelming rush to absorb them, notwithstanding the numerous trips made by sundry male and female newspaper correspondents through the tunnel under the East river, and the subsequent flaring accounts of the same.

Over in Brooklyn the situation is being simplified, in that a right battle royal seems to be on the cards. At least two of the Companies are virtually selling gas at $1 per 1,000 cubic feet, and the gas men in the balance of the State are watching the antics of the Brooklynites with feelings of disgust. As a consequence, all Brooklyn shares are lower, and we advise our readers to let the "securities" severely alone. Chicago gas is weaker on the opinion adverse to the Trust propounded by Attorney-General Moloney, but his fiat need not alarm anybody, and we strongly advise the purchase of the stock at anything under 65. Baltimore Consolidated is steady at 65½ to 65¾. In our advertising columns will be found a notice from Mr. William B. Miller, Receiver of the Cartersville (Ga.) Improvement Gas and Water Company, who offers the property for sale; and Mr. E. C. Lee, Secretary of the U. G. I. Company, announces the annual meeting of the Company, which is set for Monday, May 7th.

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Stockholders' Meeting.

OFFICE OF THE UNITED GAS IMPROVEMENT COMPANY,
DREXEL BUILDING, PHILA., April 25, 1894.

The annual meeting of the Stockholders of the United Gas Improvement Company will be held at the Company's Office, Drexel Building, Phila., on Monday, May 7th, at 12 o'clock noon, when an election will be held for a President and six Directors to serve for the ensuing year, and such other business transacted as may be brought before the meeting.

The stock transfer books will be closed from 3 P M., Tuesday, May 1st, until 10 A.M., Tuesday, May 8th.

986-1 EDWARD C. LEE, Secretary.

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A Gas Engineer

of 20 years' experience in the manufacture of coal and water gas, and in the building and general superintendence of works, desires an engagement. Satisfactory references can be given.

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by a practical engineer of many years' experience in the manufacture and distribution of gas, and has had considerable experience on construction and extensions. Good references can be furnished. Address

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of 50 horse power each. Must be in No. 1 condition and low price. Also,

One Second-Hand Station Meter,

10 inch connections.

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RECEIVER'S SALE.

By virtue of an order and decree granted by the Circuit Court of the United States, for the Northern District of Georgia, in the case of International Trust Company vs. The Cartersville Improvement Gas and Water Company et al., now pending in said Court, the undersigned, appointed receiver in said case, of all and singular the property of The Cartersville Improvement Gas and Water Company, defendant, will expose to sale at public out-cry to the highest bidder, before the Superior Court House door, in Atlanta, Ga., on the first Tuesday in July next, within legal sale hours, the following described property, to wit: The entire Gas Works, known as The Cartersville Improvement Gas and Water Company's Gas Plant, located and being in the city of Cartersville, Bartow County, Ga., consisting of the following lands, fixtures and appurtenances, to wit: A certain tract of land situated in Cartersville, Bartow County, Ga., containing one acre more or less, bounded on the north by Cook street, west by Erwin street, south and east by lands of Amos T. Akerman, deceased, being the tract of land conveyed by Martin Collins to Cartersville Improvement Gas and Water Company by deed recorded in book "A.A." of deeds, page 151, Clerk's office, Bartow Superior Court: also a certain other parcel of land, in the city of Cartersville, Bartow County, Ga., containing two acres more or less, the same being a square tract of land, each side 282 feet long, situate on Cook street, in the Third Ward of said city, boundary commencing at the intersection of the center line of Cook street with the center line of Bartow street, running from said point thence south along the east line bounding the lands of A. M. Willingham 282 feet, thence running east parallel with Cook street 282 feet, thence north parallel with the east line of said Willingham lot aforesaid to the center line of Cook street, thence along said Cook street to the point of beginning, the same being the parcel of land conveyed by William J. Neel to the Cartersville Improvement Gas and Water Company, by deed recorded in book "A.A.," pages 327 and 328, record of deeds, Clerk's office, Bartow Superior Court.

Also all buildings, machinery, improvements and equipments now located on said last described parcel of land, and used for the purpose of manufacturing, conserving, distributing and selling gas, including the engines, piping, boilers, water tanks, gasholders and oil tanks; and also all gas pipes, lamp posts, street mains, service pipes and globes, located in the city of Cartersville, Ga., and connected with said Gas Plant for the distribution of gas through said city, together with all tools, gas fixtures, fittings and supplies, rights, privileges, franchises and appurtenances belonging thereto. All of said property now being in the possession of the undersigned as Receiver aforesaid, and all to be sold by virtue of the order and decree aforesaid, as the property of the Cartersville Improvement Gas and Water Company.

The terms of sale will be as follows: One thousand dollars to be paid by the purchaser to the Receiver in cash, when the property is knocked off at said sale; one-third of the whole purchase price, including said one thousand dollars, to be paid on the confirmation of said sale by said Court; one-third to be paid in three months and one-third in six months from date of the confirmation of said sale by said Court, the said deferred payments to bear interest at the rate of six per cent. per annum from the date of confirmation of the sale as aforesaid, notes therefor to be executed and delivered by the purchaser to said Receiver, with security to be approved by said Receiver, the purchaser to have the right to pay the deferred installments at any time before the maturity thereof. The possession of the property to be delivered to the purchaser on confirmation of the sale by said Court. That upon the confirmation of the sale by the Court, and the payment of the first installment of one-third of the purchase price and delivery of the purchaser's notes to the Receiver, for the remaining installments the Receiver will execute and deliver to the purchaser, bond to make titles, on payment of the balance of the purchase money, the purchaser to be required to keep the property in reasonable repair until the purchase price is fully paid.

By virtue of said order and decree of said Court the Receiver will also receive private bids from anyone, at any time prior to the date of the public sale, same to be reported to said Court for acceptance or rejection.

For further information, address William B. Miller, Receiver of Cartersville Improvement Gas and Water Company, Cartersville, Ga.

This 24th day of April, 1894.

WILLIAM B. MILLER,
Receiver of the Cartersville Improvement
Gas and Water Company.

980-4

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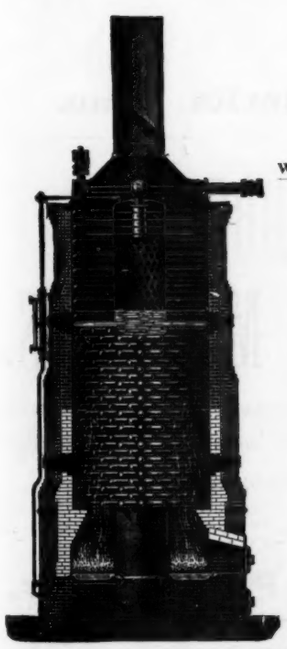

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The above illustration is taken from a photograph, and shows the Machine Room of the New Bedford Gas Co., at New Bedford, Mass. The Roof on this building was furnished by us. The building is 32 feet in width by 50 feet in length, the Roof being made entirely of iron—that is, iron trusses and iron purlins covered with corrugated iron. The room is ventilated by a wrought iron ventilator extending the full length of the building, with corrugated shutters on each side opening and closing by cords from the floor.

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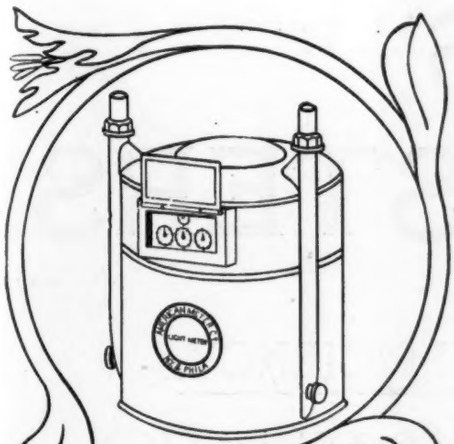

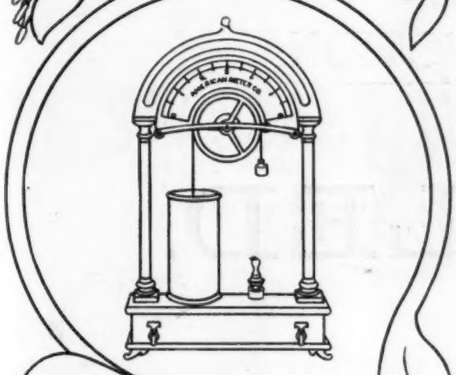

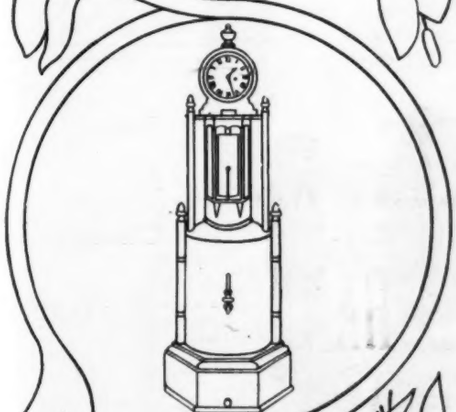

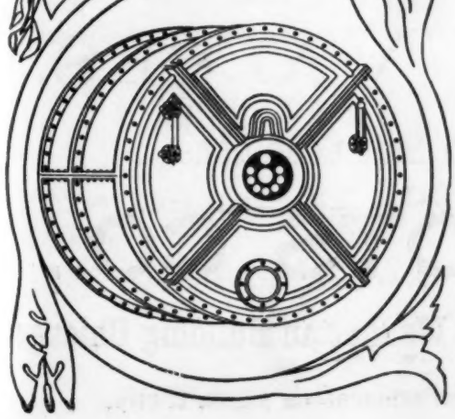

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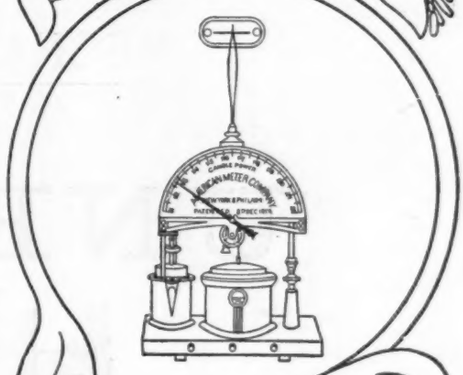
PUBLIC LIGHTING TABLE.

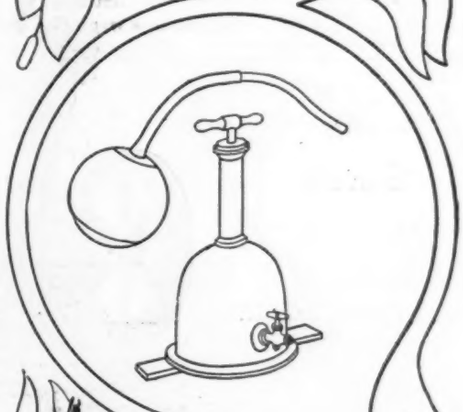
MAY, 1894.

Day of Week.	Table No. 1. Following the Moon.			Table No. 2. New York City. All Night Lighting.	
	Date.	Light.	Extinguish.	Light.	Extinguish.
				P.M.	A.M.
Tue.	1	7.20 PM	4.00 AM	6.45	4.00
Wed.	2	7.20	4.00	6.45	4.00
Thu.	3	7.30	4.00	6.45	4.00
Fri.	4	7.30	4.00	6.45	4.00
Sat.	5	7.30 NM	4.00	6.45	4.00
Sun.	6	7.30	3.50	6.45	4.00
Mon.	7	7.30	3.50	6.55	3.40
Tue.	8	7.30	3.50	6.55	3.40
Wed.	9	7.30	3.50	6.55	3.40
Thu.	10	11.10	3.50	6.55	3.40
Fri.	11	11.50	3.50	6.55	3.40
Sat.	12	12.20 AM FQ	3.50	6.55	3.40
Sun.	13	12.50	3.50	6.55	3.40
Mon.	14	1.10	3.50	7.00	3.30
Tue.	15	1.40	3.50	7.00	3.30
Wed.	16	2.00	3.40	7.00	3.30
Thu.	17	No L.	No L.	7.00	3.30
Fri.	18	No L.	No L.	7.00	3.30
Sat.	19	No L. FM	No L.	7.00	3.30
Sun.	20	7.40 PM	9.40 PM	7.00	3.30
Mon.	21	7.40	10.40	7.10	3.15
Tue.	22	7.40	11.30	7.10	3.15
Wed.	23	7.40	12.10 AM	7.10	3.15
Thu.	24	7.50	12.50	7.10	3.15
Fri.	25	7.50	1.20	7.10	3.15
Sat.	26	7.50	1.40	7.10	3.15
Sun.	27	7.50 LQ	2.00	7.10	3.15
Mon.	28	7.50	2.20	7.15	3.15
Tue.	29	7.50	2.50	7.15	3.15
Wed.	30	7.50	3.10	7.15	3.15
Thu.	31	7.50	3.30	7.15	3.15

TOTAL HOURS LIGHTING DURING 1894.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	244.10	January	423.20
February	195.30	February	355.25
March	206.20	March	355.35
April	169.40	April	298.50
May	162.10	May	264.50
June	135.40	June	234.25
July	146.30	July	243.45
August	162.20	August	280.25
September	174.10	September	321.15
October	211.20	October	374.30
November	221.00	November	401.40
December	245.30	December	433.45
Total	2274.20	Total	3987.45





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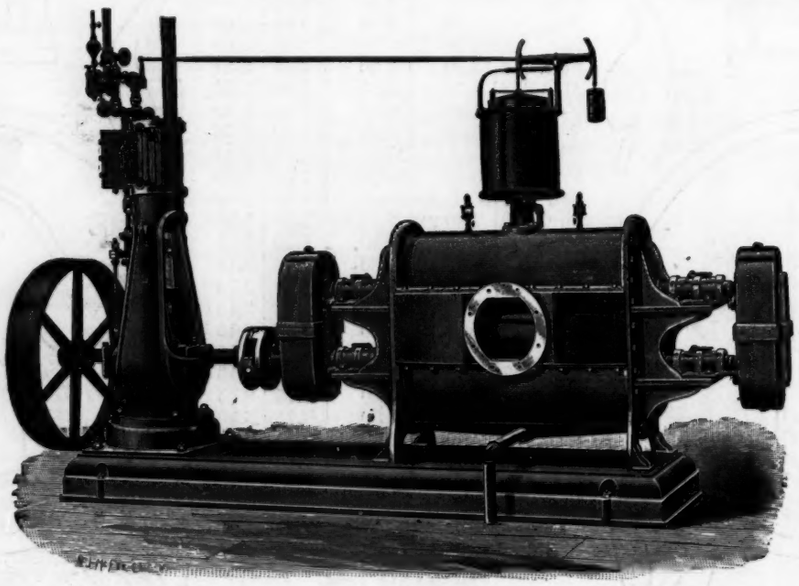

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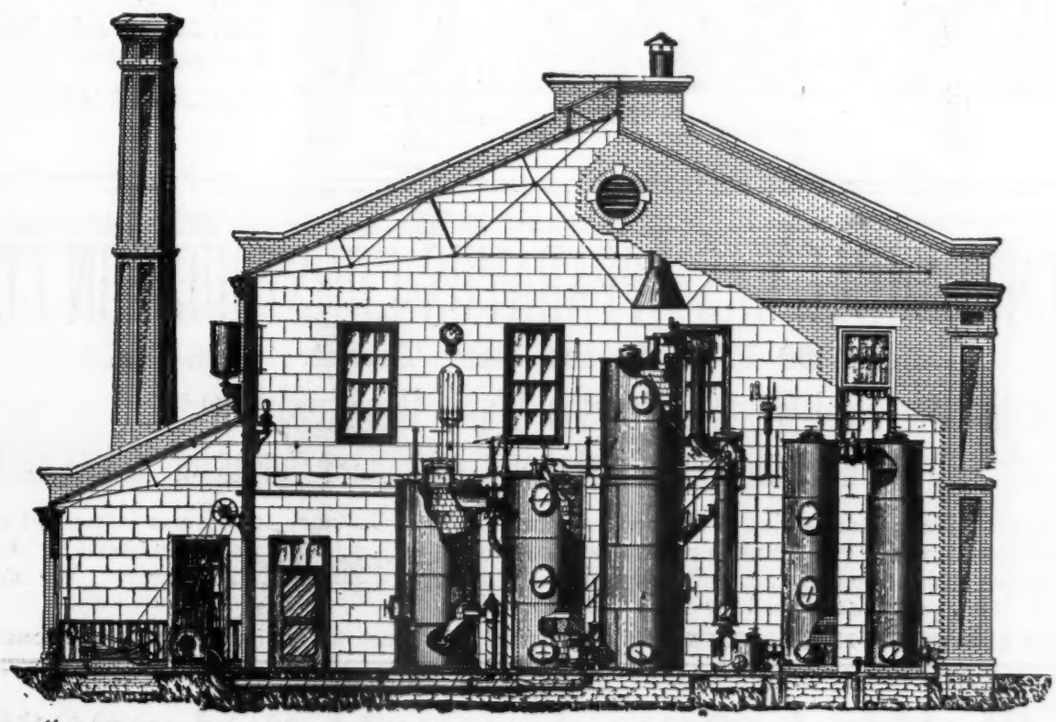

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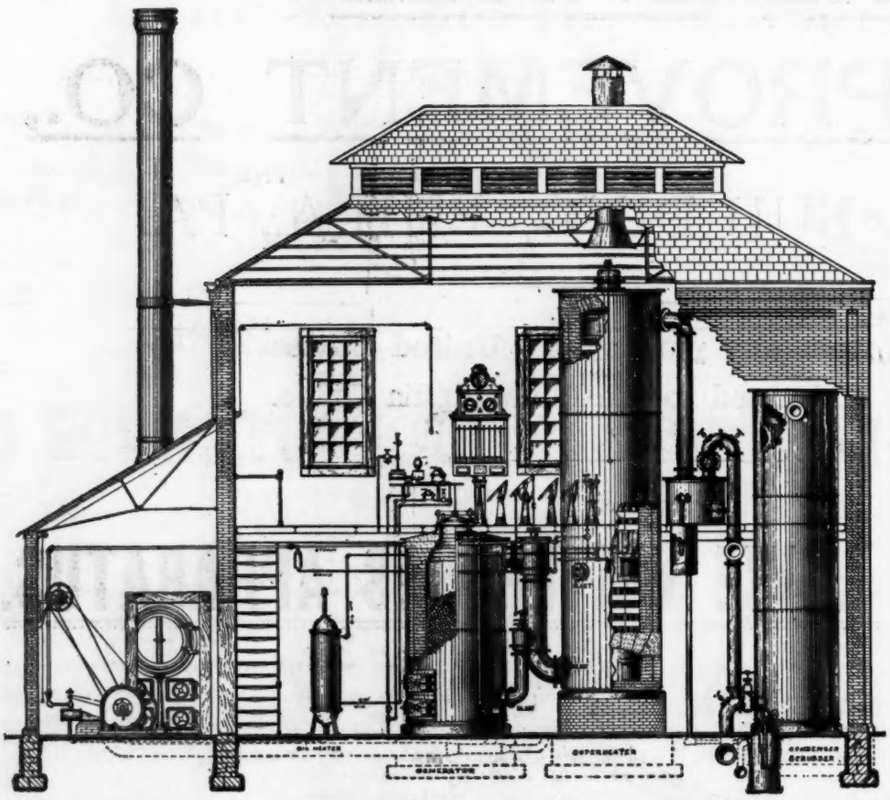

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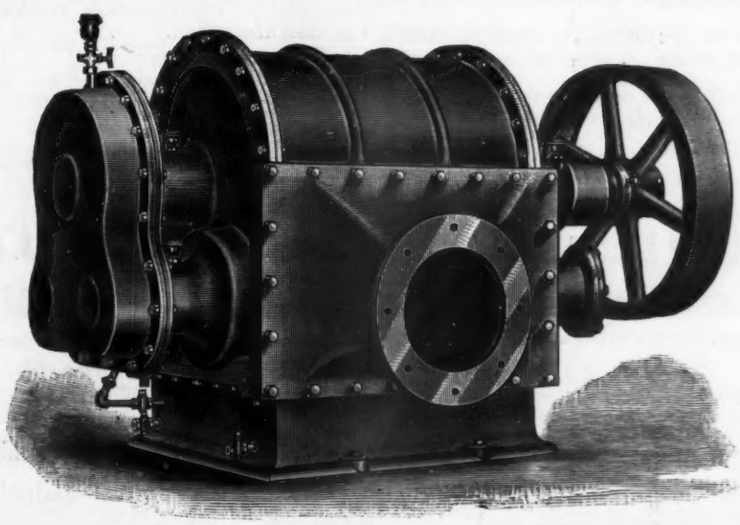

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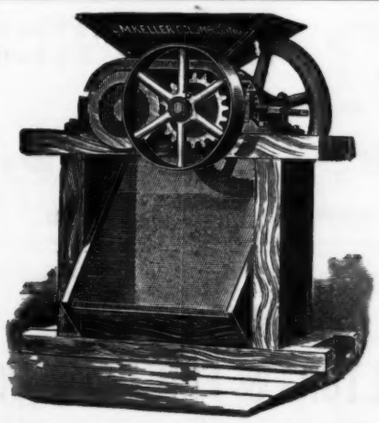

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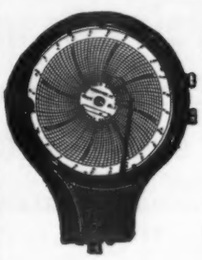

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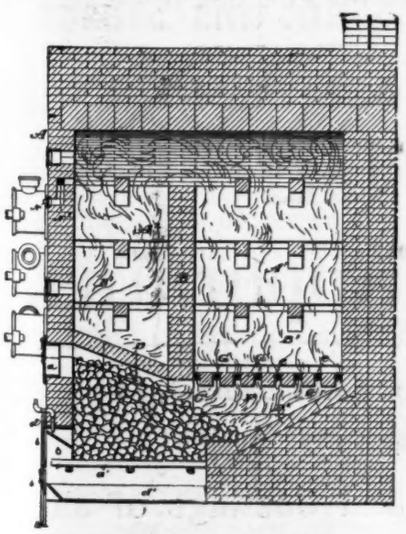

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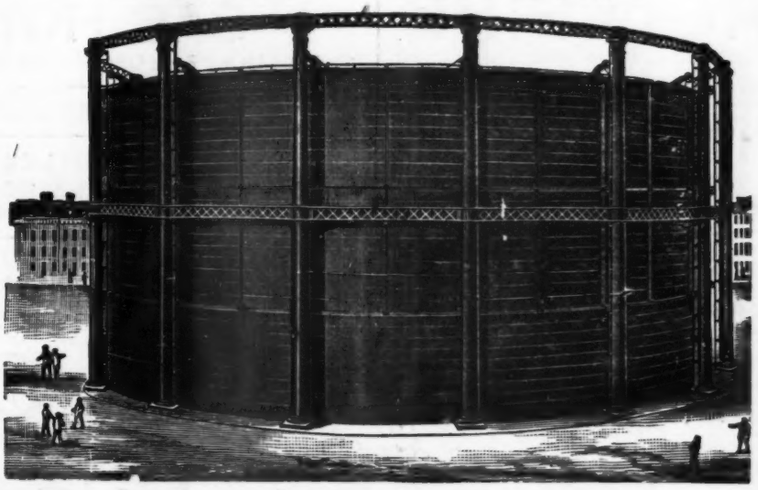

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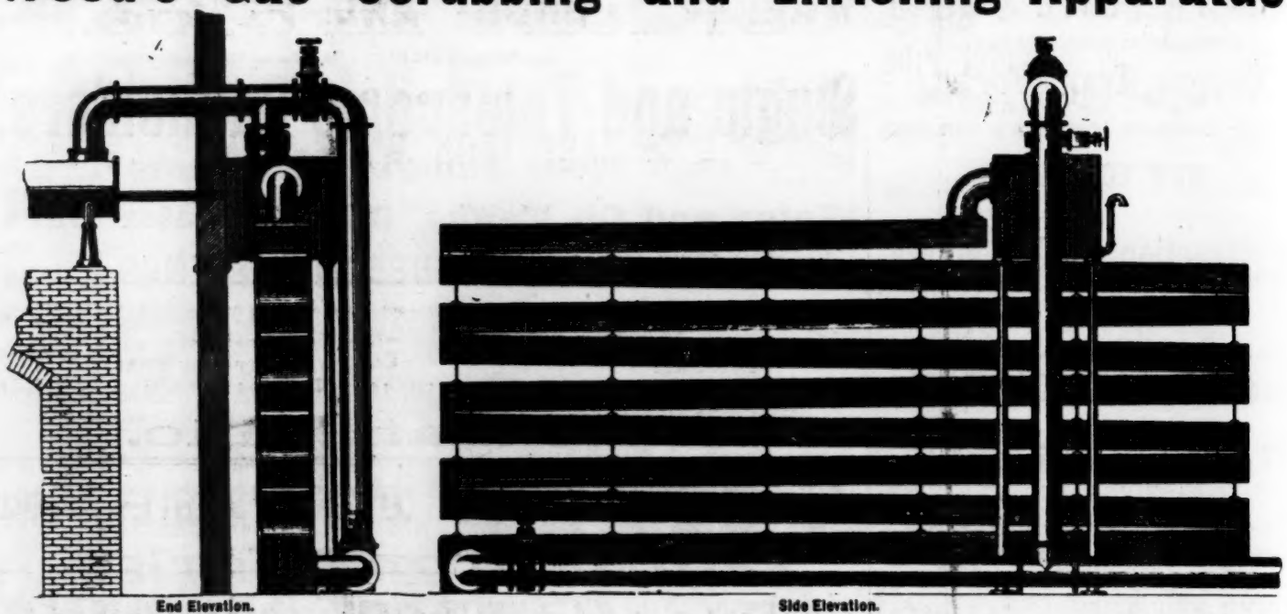

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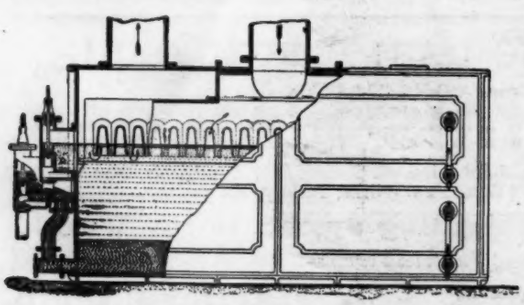

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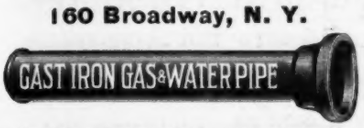

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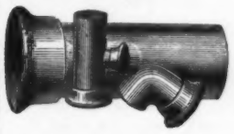

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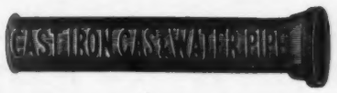

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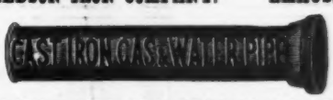

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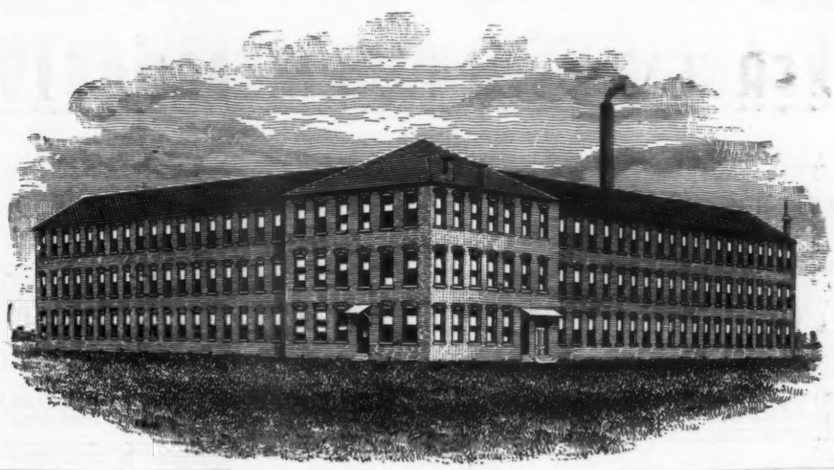

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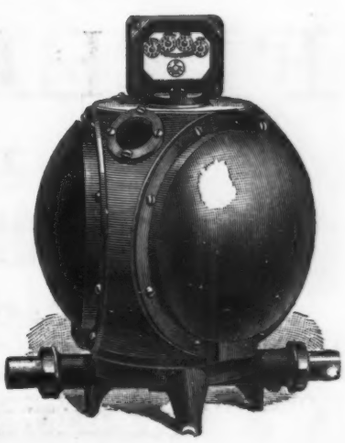

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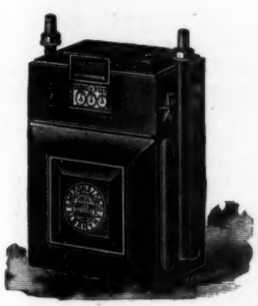

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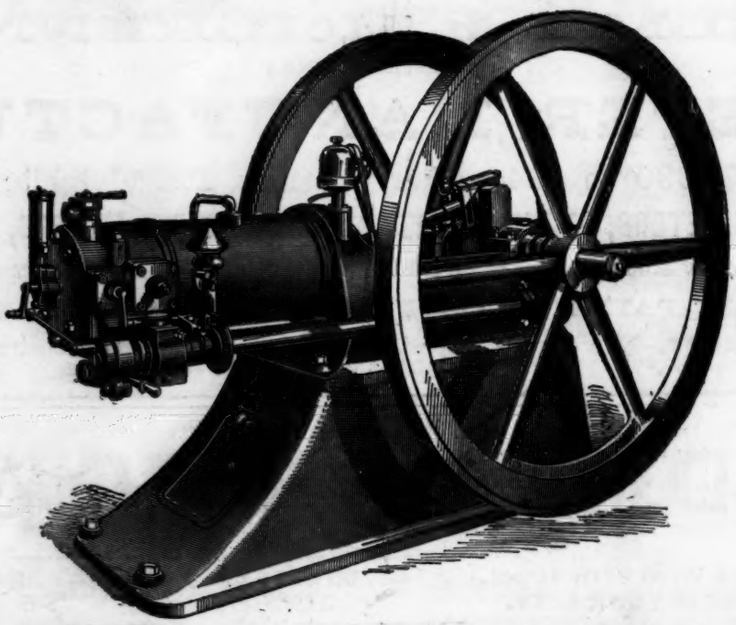

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